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ABSTRACT

As part of a comprehensive, interdisciplinary environmental education program for elementary and secondary education in Hawaii, this teaching guide provides a variety of energy education activities for secondary school mathematics. An extensive introduction outlines the total program and how it fits into the general education program and explains how to use the teaching guide which is organized around 15 core themes: energy fundamentals, evolution of energy, energy today, conservation, human dimensions, alternatives, storage and transmission systems, transportation, environmental and ecological considerations, cost, energy versus population versus food, interdependence, self-sufficiency, appropriate technology, and future perspectives. Background information is provided for each theme with related objectives and concepts. In addition a list of activities and vocabulary are given. Some of the suggested activities are presented in an elaborated form indicating subject, grade, themes, objectives, concepts, competencies, other related objectives, materials, and activity and follow-up procedures. A bibliography concludes the manual. (DC)

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Environmental Education Supplementary Instructional Guide,

ENERGY USE AND THE ENVIRONMENT

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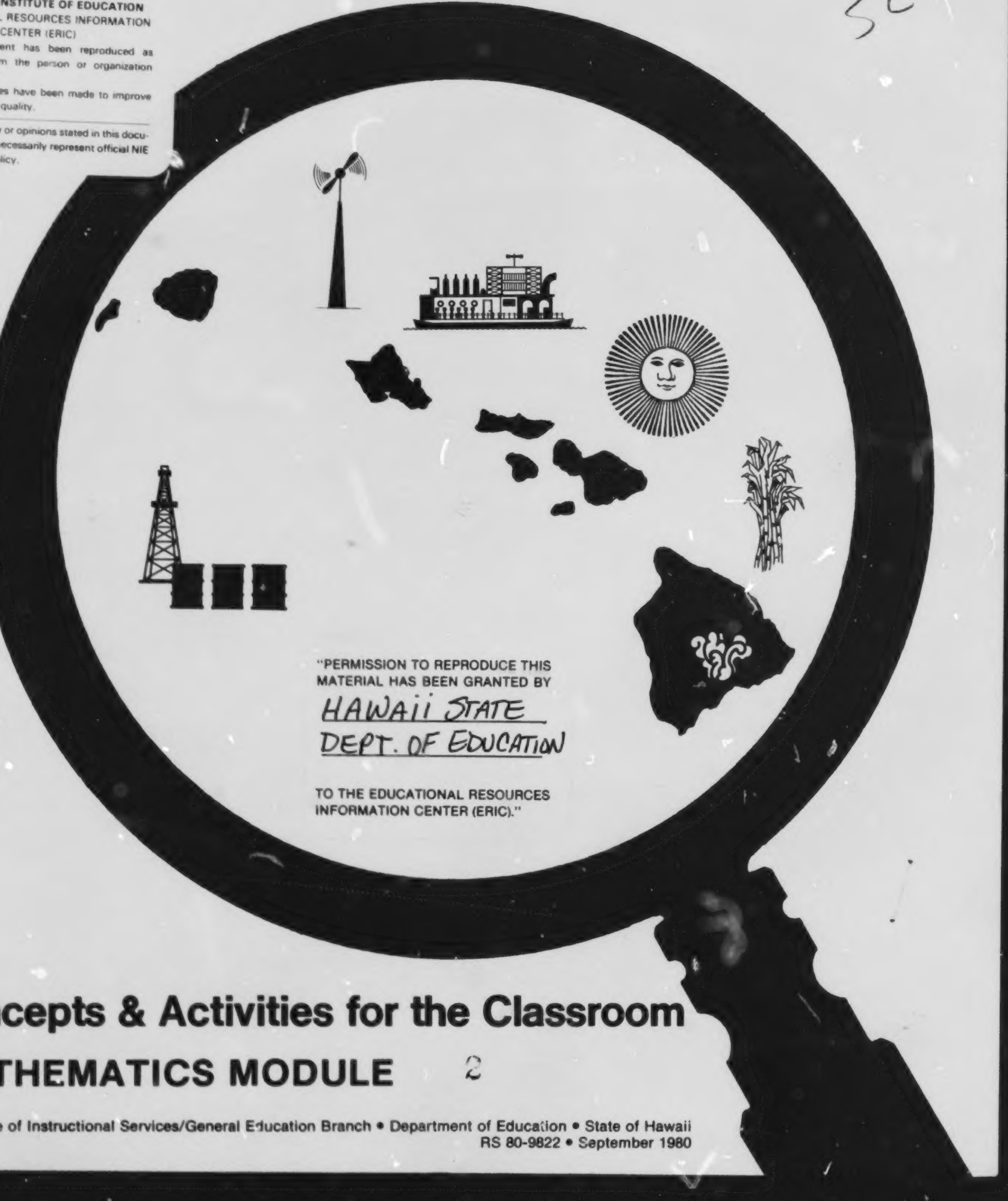

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Concepts & Activities for the Classroom

MATHEMATICS MODULE

2

Office of Instructional Services/General Education Branch • Department of Education • State of Hawaii
RS 80-9822 • September 1980

The Honorable George R. Ariyoshi
Governor, State of Hawaii

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FOREWORD

Many of the problems and issues we presently face reflect our increasing demand for energy with very little or no concern for our natural surroundings. The seriousness of today's energy situation can be viewed in terms of economic and environmental consequences as well as personal inconveniences. As a result, state, national and world attention is increasingly being focused on our need for, and wise use of, energy resources and our concern for the environment.

To cope with the reality of this world-wide energy problem, energy education must be provided for all citizens. The purpose of this kind of education is to develop an "energy literate" population that is informed about critical energy and environmental issues, can cope with change and make effective decisions in its futures-planning.

The issues [illegible]ted to energy use and the environment are becoming more complex because t[illegible] are multi-dimensional and frequently global in nature. Adding to the complexity of these issues is the growth of technical knowledge and rapidly changing political and social conditions.

If students are to adequately understand and deal with these complex and often controversial issues, they must learn to view the issues from the perspectives of the citizen, consumer, worker, and producer as well as from the scientific, economic, social, ecological, cultural, technological, legal, and political frames of reference. Students need to be encouraged to become personally involved in issues and be provided with opportunities to project energy demand and environmental concerns into a futures perspective.

The Department of Education's energy education program focuses on providing learning experiences which will enable students to thoughtfully consider various alternatives, make decisions and take responsible actions in regard to energy use and the environment. These experiences will help them to become better decision makers and problem solvers in the future.

Charles G. Clark
Charles G. Clark
Superintendent

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The Energy Use and the Environment Secondary Mathematics Program Module is the result of the cooperative efforts of many individuals and organizations. The energy education committee which drafted the initial framework and working document, Energy Education Center Staff which researched and wrote the module, teacher trainers who conducted workshops on the use of the module, and various organizations contributed toward the development of this module.

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Page

SAMPLE ACTIVITY 4-4. "More Means Less?" 105
SAMPLE ACTIVITY 4-5. "The Limits of Energy" 109

THEME 5. HUMAN DIMENSIONS OF ENERGY 115
THINGS TO DO 119
SAMPLE ACTIVITY 5-1. "Power to the People" 120

THEME 6. ENERGY ALTERNATIVES 127
THINGS TO DO 131
SAMPLE ACTIVITY 6-1. "Solar Cents" 133
SAMPLE ACTIVITY 6-2. "A Reflection of Energy" 142

THEME 7. ENERGY STORAGE AND TRANSMISSION SYSTEMS 149
THINGS TO DO 151

THEME 8. TRANSPORTATION 153
THINGS TO DO 157
SAMPLE ACTIVITY 8-1. "Moving Right Along" 159
SAMPLE ACTIVITY 8-2. "Gas and Go" 166

THEME 9. ENVIRONMENTAL/ECOLOGICAL CONSIDERATIONS 171
THINGS TO DO 175
SAMPLE ACTIVITY 9-1. "The Cost of Clean Living" 177
SAMPLE ACTIVITY 9-2. "Paper Profits" 186
SAMPLE ACTIVITY 9-3. "A Likely Occurrence" 193

THEME 10. ENERGY COST, RESPONSIBILITY AND PRIVILEGE 199
THINGS TO DO 203

THEME 11. ENERGY VS. POPULATION VS. FOOD 205
THINGS TO DO 207

THEME 12. ENERGY INTERDEPENDENCE 209
THINGS TO DO 211

THEME 13. ENERGY SELF-SUFFICIENCY 213
THINGS TO DO 215

THEME 14. APPROPRIATE ENERGY TECHNOLOGY 217
THINGS TO DO 221

TABLE OF CONTENTS

Mathematics Education Module

Page

FOREWORD i

ACKNOWLEDGMENTS ii

TABLE OF CONTENTS v

INTRODUCTION 1

OVERVIEW 5

GOAL 5

OBJECTIVES AND CORE THEMES 6

KEY ELEMENTS OF THE ENERGY EDUCATION PROGRAM 7

K-12 ENERGY EDUCATION PROGRAM DESCRIPTION 8
ORGANIZATION OF INSTRUCTIONAL MODULES 10

GUIDELINES FOR USING THE MODULES 14

ESSENTIAL COMPETENCIES 18

SYMBOL KEY FOR SUBJECT AREAS, THEMATIC AREAS AND CORE THEMES . . 19

THEME 1. ENERGY FUNDAMENTALS 21

THINGS TO DO 23

SAMPLE ACTIVITY 1-1. "Watt's Used For Power?" 24

SAMPLE ACTIVITY 1-2. "Watt's Your Pleasure" 30

SAMPLE ACTIVITY 1-3. "You Light Up My Life" 36

THEME 2. EVOLUTION OF ENERGY 41

THEME 3. ENERGY TODAY 43

THINGS TO DO 45

SAMPLE ACTIVITY 3-1. "Fuels Rush In" 46

SAMPLE ACTIVITY 3-2. "A Part of Watt?" 57

SAMPLE ACTIVITY 3-3. "Energy Eaters" 64

SAMPLE ACTIVITY 3-4. "There's No Fuel Like An Old Fuel" 75

THEME 4. CONSERVATION 81

THINGS TO DO 85

SAMPLE ACTIVITY 4-1. "Lumens vs Lumens" 87

SAMPLE ACTIVITY 4-2. "Energy Ratios" 93

SAMPLE ACTIVITY 4-3. "A Logical Conclusion" 99

Page

THEME 15. FUTURE PERSPECTIVE 223

THINGS TO DO 227

BIBLIOGRAPHY 229

INTRODUCTION

The growth of technology and the ever changing political and social conditions make it necessary for students to achieve energy literacy. Students need to be able to cope with and understand energy-related issues and problems as these relate to their own personal environment and their global environment.

> "Since education is the principal agency charged with the task of equipping the individual for a lifetime of effective living and learning, it must provide a program which will allow him/her to deal effectively with the world that is already upon him/her, as well as a yet-unknown world which is certain to converge on him/her with dramatic suddenness. Thus, planning for the future becomes urgent if we are to understand future requirements and cope with them in an orderly and efficient manner."[1]

The educational purposes as stated in the Master Plan for Public Education in Hawaii indicate the ends to which our educational system should direct its efforts. The purposes of the Department of Education are to provide students with equal opportunities for a basic education and to prepare them for the life-long process of self-education.

> "The Foundation Program is a plan to fulfill the commitment for equal opportunities in education as stated in the Master Plan for Public Education in Hawaii. It offers students the school programs through which they can acquire the fundamental skills of computation, language, the arts, the physical and social sciences. The Foundation Program also provides students with the opportunities to use and practice these skills to communicate and acquire knowledge; to pursue knowledge independently and apply that knowledge in making decisions; to grow in personal/social development; to develop and maintain good health; and to be able to choose from a variety of career opportunities.
>
> There are eight Foundation Program objectives. These statements of objectives indicate the kinds of behavior we hope to see students demonstrate as they grow into adulthood. The list of objectives covers those related behaviors that describe students as active, contributing human beings in our society."[2]

---

[1] Master Plan for Public Education in Hawaii, Department of Education, September, 1969.

[2] Foundation Program for the Public Schools in Hawaii, Department of Education, April, 1974.

The eight Foundation Program objectives are:[3]

1. Develop basic skills for learning and effective communication with others.
2. Develop positive self-concept.
3. Develop decision-making and problem-solving skills at the student's proficiency level.
4. Develop independence in learning.
5. Develop physical, social and emotional health.
6. Recognize and pursue career development as an integral part of growth and development.
7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
8. Develop creative potential and aesthetic sensitivity.

A major aim of the Department of Education's Environmental Education Program is to promote the educational purposes as stated in the Master Plan for Public Education in Hawaii and the objectives of the Foundation Program for the Public Schools in Hawaii. To accomplish this intent, the design for the Environmental Education K-12 Curriculum Guide uses statements of performance expectations, including essential competencies, program goal and objectives as translations of the educational purposes and objectives mentioned above.

The goal of the Environmental Education Program in Hawaii's schools is to develop an environmentally literate and enlightened society which, through its ethical commitment to wise use of its resources, creates and maintains optimum quality in both human-made and natural environments. Achievement of this goal will be indicated by attainment of the following objectives whereby students:[4]

1. Develop awareness of themselves in relation to their environment and the need for wise use of the environment.
2. Develop knowledge of the various aspects of the environment--land, water, sea, air, total eco-systems--and the inter-relatedness among human lives, environmental concerns and social, political, cultural and economic structures.
3. Develop skills in coping with environmental problems.
4. Develop attitudes and values which will help them to live in harmony with the environment.

---

[3] The Foundation Program's Authorized Courses and Code Numbers 1980-81, Department of Education.

[4] Environmental Education K-12 Curriculum Guide, Department of Education, December, 1978.

The major instructional goals of the six areas in the Environmental Education Curriculum Guide are given in the following list.[5]

1. Energy Use and Development: Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources.
2. Use of Earth Resources: When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs.
3. Resource Reclamation: Students will voluntarily participate in programs involving resource reclamation.
4. Population Processes and Dynamics: Students will demonstrate their awareness of population processes and dynamics.
5. Interdependence of Living Things: Students will demonstrate an appreciation for the interdependence of living things in the closed earth system.
6. Improving the Quality of Life: Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment.

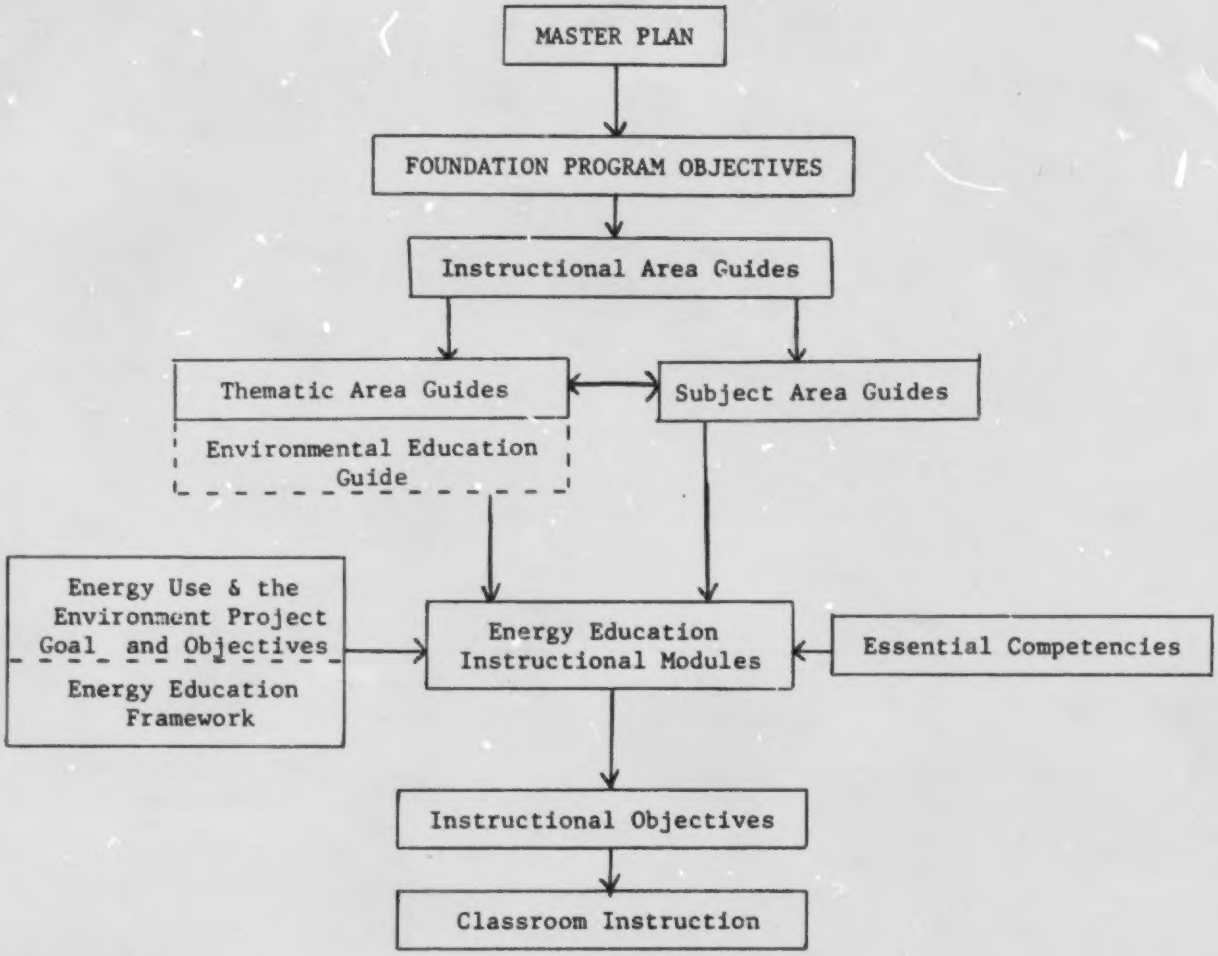
Energy is the focus of one area and is pervasive throughout the other five areas. It should also be noted that all areas are interrelated. Therefore, an energy education program has been developed as an integral part of environmental education and incorporates all of these areas.

In keeping with the environmental education format, energy education involves all instructional areas either through an interdisciplinary and/or lti-disciplinary approach. The relationship of classroom instruction in ergy Education to the Master Plan, Foundation Program, the Environmental ation Guide and the remaining instructional area guides and the essential petencies is shown in the following diagram:*

---

[5] Ibid

*The present instructional area guides consist of subject area guides in 1) Agriculture, 2) Art, 3) Asian, European and Pacific Languages, 4) Basic Practical Arts, 5) Business Education, 6) Health, 7) Home Economics, 8) Industrial Arts, 9) Industrial -Technical Education, 10) Language Arts, 11) Mathematics, 12) Music, 13) Physical Education, 14) Science, and 15) Social Studies and thematic area guides in 1) Career Education, 2) Environmental Education, 3) Guidance, 4) Library Skills, 5) Student Activities and 6) Values Education.


MASTER PLAN
FOUNDATION PROGRAM OBJECTIVES
Instructional Area Guides
Thematic Area Guides
Subject Area Guides
Environmental Education Guide
Energy Use & the Environment Project Goal and Objectives
Energy Education Framework
Energy Education Instructional Modules
Essential Competencies
Instructional Objectives
Classroom Instruction

RELATIONSHIP AMONG MASTER PLAN, FOUNDATION PROGRAM OBJECTIVES, ENVIRONMENTAL EDUCATION, SUBJECT AND THEMATIC AREAS, ESSENTIAL COMPETENCIES, AND CLASSROOM INSTRUCTION IN ENERGY EDUCATION.

By viewing the energy education program in this manner and understanding its rationale and development, teachers will realize that energy education is not a new subject. They can then review present lessons to determine what is already being done in terms of energy education and use the modules as integrative tools in their day-to-day interactions with students. In this context, the energy education modules will become meaningful, helpful and truly functional to teachers and their students.

OVERVIEW

Society has grown materially and technologically, but has not controlled many of the negative by-products of this growth. The demand for higher standards of living with little or no concern for the resulting energy and environmental problems heightens the importance of educating our young people in this area of growing concern. Thus, energy education must become part of the broader effort needed to make citizens aware of the issues and problems related to energy use and the environment.

GOAL

The goal of energy education is to develop an "energy literate" population with the necessary intellectual resources, values, attitudes, and decision-making skills to cope with problems and issues associated with energy use and the environment. The following list of traits may be used to define an energy literate person.

An energy literate person:

1. Uses energy conservation and wise-use concepts, practices, and values in making everyday decisions as he/she interacts with other people and his/her environment.
2. Understands that the generation of energy-related knowledge depends upon the inquiry process and upon conceptual theories.
3. Distinguishes between scientific evidence and personal opinion regarding energy-related matters.
4. Identifies the relationships among energy-related facts, concepts and theories.
5. Recognizes the limitations as well as the usefulness of scientific and technological research in the development of energy for improving the quality of life.
6. Has sufficient knowledge and experience so that he/she can appreciate energy-related work being carried out by others.
7. Understands the interrelatedness of science, technology and other facets of society, including social, economic, political and cultural systems, when considering issues and problems related to energy and the environment.
8. Recognizes the human origin of energy-related knowledge and understands that this knowledge is tentative and subject to change as evidence accumulates.
9. Has adopted values based on principles underlying wise and judicious use of energy and the environment.
10. Continues to inquire and increase his/her knowledge about energy and the environment throughout his/her life.
11. Uses problem-solving skills and takes appropriate actions in contributing to the solutions of energy-related problems.
12. Recognizes that energy-related decisions made today will affect his/her life and those of future generations.
13. Uses decision-making skills in assessing the outcomes of alternative actions and policies regarding preferred futures related to energy use and the environment.

OBJECTIVE AND CORE THEMES

To achieve the goal of developing an "energy literate" population, a general objective was formulated and articulated in the Energy Education Framework for each of fifteen core themes. The objectives were selected to reflect the scientific, technological, historical, social, political, economic, and human perspectives of energy issues and problems. The core themes were developed by integrating the energy-related concepts and the views from as many disciplines and interest areas within the community as possible. They are tangible, definable, relevant and "in toto" a reasonably complete representation of energy in Hawaii, yesterday, today and tomorrow.

The following is a list of core themes and general instructional objectives. Each objective is attained when the student demonstrates the general behavior defined for each theme.

1. Energy Fundamentals: Applies basic laws of science and mathematics to the study of energy.
2. Evolution of Energy: Understands the historical development of sources and uses of energy.
3. Energy Today: Knows current sources and uses of energy.
4. Conservation: Formulates and practices a conservation ethic in regard to energy use and the environment.
5. Human Dimensions of Energy: Understands that personal values and choices of energy use will affect the quality of life for all.
6. Energy Alternatives: Knows alternative energy sources and uses.
7. Energy Storage and Transmission Systems: Knows various energy storage and transmission systems.
8. Transportation: Knows a wide range of transportation modes and their energy resource requirements.
9. Environmental/Ecological Considerations: Knows various energy options and their environmental/ecological benefits and consequences.
10. Energy Cost, Responsibility and Privilege: Understands various energy cost/responsibility/privilege interrelationships.
11. Energy vs. Population vs. Food: Understands various energy/population/ food interrelationships.
12. Energy Interdependence: Understands current energy exchange practices which link nations in an economically, socially and politically interdependent manner.
13. Energy Self-Sufficiency: Understands the movement towards self-sufficiency as necessary and feasible.
14. Appropriate Energy Technology: Understands that energy technology has to fit the use to which it is put with minimum negative effects upon the quality of life.
15. Future Perspective: Utilizes decision-making and problem-solving skills in formulating plans and actions to achieve a preferred future in energy use and the environment.

KEY ELEMENTS OF THE ENERGY EDUCATION PROGRAM

To achieve the goal and objectives of energy education, this program utilizes an interdisciplinary approach, relates to the everyday life of students, considers personal values and involvement, and focuses on the decisions that will have to be made for the future. It is designed to help students understand and appreciate the impact of energy use on their past, present and future environments. In addition, energy education may provide the stimulus for some students to discover untapped sources of energy, devise new ways to use "old" sources, and invent new machines which many contribute to the solutions of our complex energy problems.

The following elements are emphasized in this program:

1. An interdisciplinary and/or multidisciplinary approach to energy education is used whenever possible. The approach emphasizes the teaching of energy as necessarily involving many subject areas to adequately educate young people about the complexity and interrelatedness of the issues and problems associated with energy use and the environment.

   The use of information and concepts from many disciplines such as science, social studies, mathematics, and economics to explain and understand energy-related problems and issues reflects the interrelatedness among science, society, and technology. For example, the application of economic concepts enables students to examine the supply and demand for various energy resources. From a technological perspective, students are able to examine the costs and benefits of new scientific procedures used to produce, convert, store, transport, and utilize these energy resources. In addition, political science concepts are useful for assessing ways in which the political processes within and among nations determine the extent to which economic efficiency and technological possibilities influence the availability of energy resources for world consumption.

2. To make energy education relevant, energy problems and issues are related to the everyday life of students. This enables students to understand energy as an important component of their daily lives. Students are encouraged to become personally involved in energy-related issues by making decisions and taking problem-solving actions.

3. Another key element of energy education is students' attitudes and personal values in making decisions. When energy-related issues and problems are integrated into the total curriculum, students become aware of their personal values as they are involved in the process of choosing from alternatives after thoughtful consideration of the consequences of each alternative. They also realize that decisions are made in light of the values and goals of a given society as a whole and each person as a member of the society.

It is important for students to understand that resources are finite and to develop a "conservation ethic" and be positively affected in their attitudes toward appropriate choice and wise use of energy resources.

4. Energy education focuses the students' attention to the future. It allows them to examine the alternatives and possible outcomes of many possible futures. This program also emphasizes that decisions and actions for a preferred future should be based on values of society, technology, and issues and facts related to energy use and the environment.

   Students should realize that they must have an active say in what kind of future they want. They must also understand that decisions made today will affect both their own lives and those of generations to come.

   This orientation of energy education to the future will help students realize the importance of being flexible and adaptable. It will also enable them to better cope with rapidly changing technology and political, social and economic circumstances affecting energy use and the environment.

K-12 ENERGY EDUCATION PROGRAM DESCRIPTION

Energy education is not a new subject. A review of present curriculum guides can determine what is already being done in terms of energy education. The task of implementing energy education is primarily one of refocusing what is now being done, rather than trying to add another new subject.

The major components of the planned energy education effort of the Department of Education are designed to assist teachers in implementing energy education in the public schools of Hawaii. They include:

1. An assessment of present curriculum guides. The following chart indicates where core themes of the Energy Use and the Environment Project are directly or indirectly mentioned in the various instructional area guides.

ASSESSMENT OF K-12 CURRICULUM GUIDES
CORRELATION OF CORE THEMES
WITH INSTRUCTIONAL AREAS

LEGEND:

The position of the numbers represents grade levels.

- Upper left corner represents grades K-3
- Lower left corner represents grades 4-6
- Upper right corner represents grades 7-9
- Lower right corner represents grades 10-12

K-3	7-9
4-6	10- 12

The numbers on the chart represent the degree to which energy education is covered.

0 - No mention of energy education.
1 - Indirect mention of energy education.
2 - Direct mention of energy education.

INSTRUCTIONAL AREAS / CORE THEMES	ELEMENTARY/SECONDARY								ADDITIONAL SECONDARY						
	Art	Health	Language Arts	Mathematics	Music	Physical Education	Science	Social Studies	Agriculture	Asian, European and Pacific Languages	Basic Practical Arts	Business Education	Home Economics	Industrial Arts	Industrial-Technical Education
1. Energy Fundamentals	0 0 0 0	1 2 1 2	0 0 0 0	1 1 1 1	0 0 0 0	1 1 1 1	2 2 2 2	0 1 0 1	0 1	0 0	2 0	0 0	0 2	0 2	0 2
2. Evolution of Energy	1 1 1 1	0 0 0 0	1 1 1 1	0 0 0 0	1 1 1 1	0 0 0 0	2 2 2 2	2 2 2 2	0 1	1 1	1 0	0 1	0 1	0 1	0 1
3. Energy Today	1 1 1 1	1 1 1 1	1 1 1 1	0 1 0 1	1 1 1 1	0 1 1 1	2 2 2 2	2 2 2 2	0 1	1 1	2 0	0 2	0 1	0 1	0 1
4. Conservation	1 1 1 1	1 1 1 1	1 1 1 1	0 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	0 2	1 1	2 0	0 2	0 2	0 2	0 2
5. Human Dimensions of Energy	2 2 2 2	2 2 2 2	2 2 2 2	0 1 1 1	1 1 1 1	0 1 1 1	2 2 2 2	2 2 2 2	0 2	2 2	2 0	0 2	0 2	0 2	0 2
6. Energy Alternatives	1 1 1 1	0 0 0 0	0 1 1 1	0 1 1 1	0 0 0 0	0 0 0 0	2 2 2 2	1 2 1 2	0 1	1 1	2 0	0 1	0 2	0 2	0 2
7. Energy Storage and Transmission Systems	0 0 0 0	0 0 0 0	0 0 0 0	0 1 1 1	0 0 0 0	0 0 0 0	0 2 1 2	0 2 0 2	0 0	0 0	1 0	0 0	0 1	0 1	0 2
8. Transportation	1 1 1 1	1 1 1 1	1 1 1 1	0 1 1 1	0 0 0 0	0 0 0 0	1 2 1 2	1 2 1 2	0 2	2 2	1 0	0 2	0 1	0 2	0 2
9. Environmental/Ecological Considerations	2 2 2 2	2 2 2 2	2 2 2 2	0 1 0 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2	0 2	1 1	2 0	0 2	0 2	0 2	0 2
10. Energy Cost, Responsibility and Privilege	0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	0 0 0 0	1 1 1 1	1 2 1 2	1 2 2 2	0 1	0 0	2 0	0 2	0 2	0 2	0 2
11. Energy vs. Population vs. Food	0 0 0 0	1 1 1 1	1 1 1 1	0 1 1 1	0 0 0 0	0 0 0 0	2 2 2 2	2 2 2 2	0 2	2 2	2 0	0 2	0 2	0 0	0 0
12. Energy Interdependence	0 0 0 0	0 0 0 0	0 1 0 1	0 1 1 1	0 1 0 1	0 0 0 0	0 2 1 2	1 2 2 2	0 2	2 2	1 0	0 2	0 1	0 1	0 1
13. Energy Self-Sufficiency	0 0 0 0	0 0 0 0	0 1 0 1	0 1 1 1	0 0 0 0	0 0 0 0	0 2 1 2	0 2 1 2	0 1	1 1	1 0	0 2	0 1	0 1	0 1
14. Appropriate Energy Technology	1 1 1 1	0 0 0 0	1 1 1 1	0 1 1 1	0 0 0 0	0 0 0 0	2 2 2 2	1 2 1 2	0 2	1 1	2 0	0 1	0 2	0 2	0 2
15. Future Perspective	1 1 1 1	0 0 0 0	2 2 2 2	1 1 1 1	0 0 0 0	0 1 1 1	2 2 2 2	2 2 2 2	0 2	1 1	2 0	0 2	0 2	0 2	0 2

2. A resource handbook. This handbook is a compilation of background information, helpful hints about teaching strategies and content organization, practical ideas for classroom activities and suggested reference materials and resources available to teachers and students. It includes lists of reference books, curriculum materials, films, field trips, speakers, etc. The handbook is intended to be a practical reference guide.

3. Student assessment/evaluation instruments for each grade level in the elementary school (K-6) and for various subject areas at the secondary level. These instruments include pre- and post-tests to assess and evaluate the progress of students in their attainment of energy-related concepts.

4. Instructional modules for each grade level in the elementary school (K-6) and for various subject areas at the secondary level (Basic Practical Arts, Science, Social Studies, etc.). These modules are composed of suggested activities based on the fifteen core themes that form the framework for the Energy Use and the Environment Project. They were designed to emphasize and integrate energy-related concepts, issues, and problems within the existing instructional areas.

ORGANIZATION OF INSTRUCTIONAL MODULES

The modules are intended to give the teacher an orientation, background information and general suggestions for teaching activities related to energy use and the environment. Each module is organized by core themes. The foreword, introduction and overview sections are color coded in yellow. The "Background Information" pages for each theme are color coded in green throughout the module while the "Things To Do" and "Sample Activity" pages are white. The components of these pages are described on the format pages that follow.

20

"BACKGROUND INFORMATION" PAGE FORMAT

THEME (Number). TITLE

BACKGROUND

A brief description of the theme and its significance to energy education.

FOUNDATION PROGRAM OBJECTIVES

A list of the Foundation Program Objectives (FPO's) appropriate to the theme.

CORE THEME OBJECTIVE

A statement of the general instructional objective of the theme.

CONCEPTS

A list of important concepts of the theme. It represents some key perspectives and interests about energy but is not exhaustive.

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

Taken from various subject area program guides, a list of goals and/or general objective statements related to the theme. (The page number listed refers to that of the guide from which the goal or objective was taken.)

DESCRIPTION OF COMPONENTS OF THE "BACKGROUND INFORMATION" PAGE FOR EACH CORE THEME.

The "Background Information" pages for the fifteen core themes are included in all of the modules, i.e., for all grade levels and subject areas. These pages appear in green throughout the modules.

"THINGS TO DO" PAGE FORMAT

THEME (Number). Title

Subject Area ____________
Grade Level ____________

THINGS TO DO

A list of suggested classroom activities that are appropriate to the theme. An activity marked with an asterisk (*) indicates that a detailed explanation is given on the "Sample Activity" pages that follow the list.

VOCABULARY

A list of suggested key words for the theme. The teacher should determine which words are appropriate for a particular class or group of students.

DESCRIPTION OF COMPONENTS OF THE "THINGS TO DO" PAGE FOR CORE THEMES EMPHASIZED IN A GIVEN GRADE LEVEL OR SUBJECT AREA.

Although only a few themes are emphasized in any given grade level or subject area, all of the themes are covered in the combined set of modules in the overall K-12 program. For each core theme that is emphasized, the module includes a "Things To Do" page. Note that the blank space for subject area in the upper right hand corner of this page will be used to list areas directly related to one or more of the activities listed under "Things To Do." These pages appear in white throughout the modules.

"SAMPLE ACTIVITY" PAGE FORMAT

THEME (Number). Title

Subject Area ____________
Thematic Area ____________
Grade Level ____________

SAMPLE ACTIVITY (Number). Title

OBJECTIVE

Statement of general objective of the core theme.

CONCEPTS

A list of selected core theme concepts appropriate to the sample activity.

ESSENTIAL COMPETENCIES

A list of essential competencies (EC's) appropriate to the activity.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

A list of instructional goals and/or objectives from the Environmental Education K-12 Curriculum Guide which are appropriate to the activity.

INSTRUCTIONAL OBJECTIVES

A list of appropriate general and/or specific instructional objectives or performance expectations (PE's) taken from subject area curriculum guides.

SUGGESTED MATERIALS AND/OR RESOURCES

A list of suggested materials and/or resources appropriate to the activity.

ACTIVITY (Related Core Themes: __)

A detailed explanation of the activity which includes suggested procedures and relationships to other appropriate core themes.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

A list of activities which may be helpful in assessing students and/or summarizing the sample classroom activity.

DESCRIPTION OF COMPONENTS OF THE "SAMPLE ACTIVITY" PAGE FOR SAMPLE CLASSROOM ACTIVITIES.

Some of the classroom activities listed on the "Things To Do" page are explained in detail on the "Sample Activity" page. Note that the blank space for subject area in the upper right hand corner of the "Sample Activity" page will be used to list areas directly related to the instructional objective of the activity and, in the parenthesis following, a list of other areas which involve skills and attitudes related to the activity. The thematic area blank space will list those thematic instructional areas that involve skills and/or attitudes relevant to the sample activity. The "Sample Activity" pages appear in white throughtout the modules.

GUIDELINES FOR USING THE MODULES

The following guidelines are offered to assist teachers in using the energy education modules. The modules are designed to provide students with experiences which stimulate creative social and scientific thinking, exploration, decision-making and problem-solving of energy-related issues.

1. The teacher is free to use the modules in any manner. It is the responsibility of each teacher to select the themes, objectives, concepts, and activities which reflect his/her instructional objectives and the needs of a particular class or group of students.

2. The time needed to complete a module varies from one to two or more weeks depending upon the number of activities selected. Whether the activities are used in total or in part will be determined by the age, ability level and interest of the students. Some activities lend themselves to periodic observations over a few months while others can be done in a few days.

3. Core themes appropriate to the ability levels of students and/or subject areas were selected for emphasis at each grade level in the elementary school and various subject areas at the secondary level. The following chart indicates the level of emphasis of each core theme in the various modules of the K-12 energy education program.

4. Worksheets and Exercises are written for the students; therefore are printed on white for easy reproduction. For the secondary level modules, the "Things To Do" pages are also written for the students and are also on white sheets.

LEVELS OF EMPHASIS OF CORE THEMES IN THE K-12 ENERGY EDUCATION PROGRAM

Emphasis

+ Heavy
✓ Some
- Little
0 None

Core Themes / Grade Level and/or Subject Area	Elementary (K-6) (Grade Level)							Secondary (7-12) (Subject Area)														
	Kindergarten	First	Second	Third	Fourth	Fifth	Sixth	Agriculture	Art	Foreign Language	Basic Practical Arts	Business Education	Health	Home Economics	Industrial Arts	Vocational - Technical Education	Language Arts	Mathematics	Music	Physical Education	Science	Social Studies
1. Energy Fundamentals	-	-	-	✓	✓	✓	+	✓	-	0	✓	0	-	✓	+	+	0	✓	0	-	+	-
2. Evolution of Energy	-	-	-	✓	✓	+	✓	✓	✓	-	+	✓	0	+	✓	✓	✓	0	✓	0	✓	+
3. Energy Today	✓	✓	✓	✓	+	+	+	+	✓	✓	+	+	✓	+	+	+	✓	✓	✓	✓	+	+
4. Conservation	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5. Human Dimensions of Energy	-	-	-	-	✓	✓	+	✓	✓	✓	✓	✓	+	+	✓	✓	+	✓	✓	✓	✓	+
6. Energy Alternatives	0	0	0	-	✓	✓	✓	-	✓	-	✓	✓	0	-	+	+	✓	✓	0	0	+	✓
7. Energy Storage and Transmission Systems	0	0	0	-	-	-	-	0	0	0	-	0	0	-	✓	✓	0	✓	0	0	+	-
8. Transportation	-	-	-	✓	✓	✓	✓	+	-	+	✓	✓	-	✓	+	+	-	+	-	-	✓	✓
9. Environmental/Ecological Considerations	0	0	-	-	-	✓	✓	+	+	-	✓	-	+	✓	✓	✓	+	✓	✓	✓	+	+
10. Energy Cost, Responsibility and Privilege	0	0	0	0	-	✓	✓	-	✓	0	✓	+	0	✓	-	-	✓	✓	0	0	-	+
11. Energy vs. Population vs. Food	0	0	0	-	-	-	✓	✓	0	✓	+	✓	✓	+	0	0	-	-	0	0	✓	✓
12. Energy Interdependence	0	0	0	0	-	-	✓	✓	-	+	✓	+	-	-	✓	✓	✓	-	-	0	-	✓
13. Energy Self-Sufficiency	0	0	0	0	-	-	✓	+	0	-	✓	✓	0	✓	✓	✓	✓	-	0	0	✓	+
14. Appropriate Energy Technology	0	0	0	0	-	-	-	+	-	-	-	-	0	✓	+	+	-	-	0	0	+	✓
15. Future Perspective	0	-	-	-	✓	✓	✓	✓	✓	-	✓	✓	-	✓	+	+	✓	✓	✓	-	+	✓

4. The major instructional emphasis of the modules is concept attainment. To achieve the goal of energy literacy, students must learn and understand basic natural and social science concepts along with problem-solving and decision-making skills. These concepts and skills will enable students to accurately describe and explain today's energy situation and to examine energy alternatives.

   a. The first level of concept attainment being sought is the comprehension of a concept. The ability to cite new and/ or different examples demonstrates understanding or comprehension of a concept. Thus, learning experiences should include opportunities for students to manipulate newly learned concepts. Students should be encouraged to discuss main ideas of the concept, define a concept in their own words, use vocabulary associated with the concept, and cite new examples of the concept.

   b. The second level of concept attainment being sought is the application of concepts to energy-related issues. In other words, concepts become most useful when they are applied to relevant or personal problem-solving situations.

5. Most young children in the primary grades (K-3) are not able to deal with abstract concepts. Therefore, the suggested activities reflect and emphasize student awareness of energy use and the environment rather than a formal study of energy. In the upper grade levels (grades 4-12), however, students can be made aware of problems and issues of energy through concepts and use of energy-related language.

6. The skills and attitudes associated with the various thematic areas of instruction should be incorporated into appropriate energy education activities whenever possible. This has been done for Environmental Education. For the other thematic areas, refer to the guides on Career Education, Guidance, Library Skills, Student Activities and Values Education for suggestions. The major goals of these areas are:

   a. Career Education: (1) achievement of self-realization; (2) development of capability to maintain social relationships; (3) development of capability to fulfill civic responsibility; and (4) development of capability to achieve economic efficiency through producer and consumer roles.

   b. Foundation Guidance Program: (1) personal growth and development; (2) social growth and development; (3) educational planning and development; and (4) career planning and development.

   c. Library Skills: To help students develop the skills needed to become independent, resourceful users of information.

   d. Student Activities: To provide experiences which will enable each individual to learn to think and act intelligently in achieving maximum self-fulfillment and in preserving, and contributing to the strength of his/her school, community, state, nation and world.

   e. Values Education: To help each individual become a self-fulfilling, fully functioning person.

7. Because the core themes are statements derived from many existing community perspectives, their educational use is not necessarily limited to specific subject areas. They can be applied to a number of subject areas as individual unit themes or as combined study cores while maintaining the integrity of each subject area. Where appropriate, the activities suggested are interdisciplinary and/or multidisciplinary.

8. Since there are many interrelationships among the core themes, some of the suggested classroom activities have been listed in an emphasized area rather than within several themes. For example, the modules for grades K-3, activities related to Theme 5, "Human Dimensions of Energy," have been incorporated into Theme 4, "Conservation," to simplify the lessons for the primary school children. In the description of the appropriate sample activities of Theme 4, this relationship is noted as "(Related Core Theme: 5)."

9. The background information for each theme has been written for all teachers from kindergarten through the secondary school. The objectives and concepts are broad and general statements which are common to all grade levels (K-12). They differ only in the degree to which students in various grade levels attain them.

10. The suggested activities listed as "Things To Do" become more and more complex and sophisticated as students progress through the grade levels.

11. The modules are intended to give the teacher an orientation, background information and general suggestions for teaching activities related to energy use and the environment. It is hoped that teachers will use these materials as a starting point and be encouraged to adapt and create lessons in meeting the need for developing an "energy literate" population. For example, if teachers select core themes which do not have "Things To Do" and/or "Sample Activity" pages, they are encouraged to follow the format of sample activities given in the modules. They should consider:
    a. Foundation Program Objectives (FPO's) and Essential Competencies (EC's);
    b. Energy education core theme objective and concepts;
    c. Goals and/or general objectives of environmental education and other subject and thematic areas of instruction; and
    d. Instructional objectives of subject areas appropriate to the lesson being developed.

ESSENTIAL COMPETENCIES

Appropriate essential competencies (EC's) are listed for each sample activity. These are taken from the fifteen competencies identified by public validation to be the minimum required for every high school graduate to function in the adult world as productive and contributing members of society. The essential competencies are: [6]

1. Read and use printed materials from daily life.
2. Complete commonly used forms.
3. Demonstrate writing skills commonly used in daily life.
4. Communicate orally in situations common to everyday life.
5. Use computational skills in situations common to everyday life.
6. Read and use scales on standard measuring devices.
7. Interpret common visual symbols.
8. Reach reasoned solutions to commonly encountered problems.
9. Distinguish fact from opinion in TV and radio news broadcasts, advertising, newspaper and magazine articles, and public speeches.
10. Use resources for independent learning.
11. Identify the harmful effects of smoking, drinking, drug abuse, overeating, insufficient sleep, poor personal hygiene, and poor nutrition.
12. Identify the training, skill and background requirements of at least one occupation in which the student is interested.
13. Demonstrate knowledge of the basic structure and functions of national, state and local governments.
14. Demonstrate knowledge of the citizen's opportunities to participate in political processes.
15. Demonstrate knowledge of important citizen rights and responsibilities.

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[6] Student Performance Expectations of the Foundation Program, Department of Education, August, 1978.

SYMBOL KEY FOR SUBJECT AREAS, THEMATIC AREAS, AND CORE THEMES

The following abbreviations are used throughout the modules to indicate the subject and/or thematic areas related to the energy education activities.

Elementary/Secondary

Subject Areas

Art	Art
H	Health
LA	Language Arts
M	Mathematics
Mus	Music
PE	Physical Education
Sc	Science
SS	Social Studies

Additional Secondary Subject Areas

Ag	Agriculture
AEP	Asian, European and Pacific Languages
BPA	Basic Practical Arts
Bus	Business Education
HEc	Home Economics
IA	Industrial Arts
IT	Industrial-Technical Education

Thematic Areas

CE	Career Education
EE	Environmental Education
G	Guidance
LS	Library Skills
SA	Student Activities
VE	Values Education

The following numbers are used throughout the module to indicate the core themes related to a specific sample activity.

Core Themes

1. Energy Fundamentals
2. Evolution of Energy
3. Energy Today
4. Conservation
5. Human Dimensions of Energy
6. Energy Alternatives
7. Energy Storage and Transmission Systems
8. Transportation
9. Environmental/Ecological Considerations
10. Energy Cost, Responsibility and Privilege
11. Energy vs. Population vs. Food
12. Energy Interdependence
13. Energy Self-Sufficiency
14. Appropriate Energy Technology
15. Future Perspective

THEME 1. ENERGY FUNDAMENTALS

BACKGROUND

Theme 1 deals with a definition of energy and the basic laws of science and mathematics as they apply to the study of energy and its technological implications. Understanding of these energy fundamentals will help students appreciate the vital role that energy plays in their lives. This theme will also enable them to understand options, make decisions and/or take positive problem-solving actions which are related to energy use and the environment.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision - making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.

CORE THEME OBJECTIVE

To apply laws of science and mathematics to the study of energy.

CONCEPTS

1. Energy is the capacity to do work and is subject to natural laws.
2. All living things and natural processes require energy.
3. The sun is the basic source of energy on earth.
4. Energy exists in many forms.
5. Energy can neither be created nor destroyed but can be converted from one form to another.

THEME 1. Energy Fundamentals

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 54-56 - Units I & II) The application of scientific principles aids people to cultivate economic plants. People's ability to bring about optimal conditions for animal growth and development is dependent upon their scientific knowledge and technical skills.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively meet the basic necessities of life in order to sustain life to the optimum.

HEALTH: (pg. 1 (7-12) - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experience contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Purchase consumer goods and services appropriate to an overall consumption plan and wise-use of economic resources.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an understanding of the principles, concepts, and problems of industrial technology.

MATHEMATICS: (pg. 13 - Goals) Develop ability to think critically and to solve problems.

PHYSICAL EDUCATION: (pg. 106 - Objective) Move skillfully and know the concepts relevant to all physical movement.

SCIENCE: (pg. 13 - Objectives) 1. Nurture in our children a curiosity and excitment about the biophysical environment. 2. Teach students to value science as one way of learning and communicating effectively about self, others and the environment. (Develop a longing to know and understand.)

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to interpret and accurately use symbols, figures, and models by which scientifically gathered information is related and displayed (e.g., maps, tables, graphs, charts).

THEME 1. Energy Fundamentals

Subject Area Mathematics
Grade Level 7-12

THINGS TO DO[1]

*1. Calculate the amount of KWH consumed by your family each week. Each year. How many barrels of oil does the KWH of electricity consumed by your family represent? (See Sample Activity 1-1. "Watt's Used For Power?")

*2. Conduct a home energy audit. Do an inventory of the 5 most used appliances in your home and calculate the annual hours of operation, the annual KWH used, and the annual cost of operation. (See Sample Activity 1-2. "Watt's Your Pleasure?")

*3. The sun is the basic source of energy on earth. How big is the sun? How much of the sun's energy reaches the earth? (See Sample Activity 1-3. "You Light Up My Life.")

4. Study the power consumption data on various appliances. Calculate the energy consumed by each appliance. What information is necessary to calculate energy consumption?

5. Calculate the energy required to move your body weight one mile by walking. Contrast this with energy required to move one mile by bicycle; one mile by automobile.

VOCABULARY

Amperes, British Thermal Unit (BTU), calorie, electricity, energy, energy conversion, energy efficiency ratio, energy transformation, kilowatt, kilowatt-hour, light energy, per capita, power, volts, watt, watt-hour, work.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Science textbooks.
b. Mathematics in Energy, Student/Teacher Materials in Energy, the Environment, and the Economy (EEE). Prepared for the U.S. Department of Energy by the National Science Teachers Association, Washington, D.C., November 1978.
c. Fuel and Electricity. Office of Instructional Services, Department of Education, Honolulu, Hawaii, July 1972 (unofficial publication).
d. Energy Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D. C., 1975.

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* For detailed description, refer to noted Sample Activity.

THEME 1. Energy Fundamentals

Subject Area Math (HEc, Sc, SS)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 1-1. "Watt's Used for Power?"

OBJECTIVE

- To apply laws of science and mathematics to the study of energy.

CONCEPTS

- Energy is the capacity to do work and is subject to natural laws.
- All living things and natural processes require energy.
- Energy exists in many forms.
- Energy can neither be created nor destroyed but can be converted from one form to another.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 2. Complete commonly used forms.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option X, Level A)

- Adds, subtracts, multiplies, and divides whole numbers, fractions, and decimals. (pg. 122)
- Solves simple equations in one unknown. (pg. 122)
- Estimates and rounds off as needed. (pg. 122)
- Solves problems involving measurement. (pg. 123)

Theme 1. Energy Fundamentals

Sample Activity 1-1

Grade Level 9-12

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 1.1.
2. Worksheet 1.1.

Theme 1. Energy Fundamentals

Sample Activity 1-1

Grade Level 9-12

ACTIVITY (Related Core Themes: 3, 4, 5 & 10)

Electricity is one of the most common ways we consume energy today. We can produce electricity using any energy source but at present fossil fuels such as coal, oil and natural gas produce most of our electrical needs. Electricity is also produced by hydroelectric and nuclear power plants. In Hawaii, 90% of our electricity is generated using petroleum, while in the continental U.S.A. it is only 24%. (About 9% of Hawaii's electrical energy comes from sugar factories burning bagasse (sugar cane wastes) supplemented periodically with oil.)

Approximately 60% of the energy used by an island resident is for electricity. In 1979 the average island household of 6 consumed 18,430 kilowatt hours of electricity. (Electric power is measured in watts. All electrical appliances and light bulbs are rated in watts or kilowatts: one kilowatt is equal to 1000 watts. A kilowatt hour is 1000 watts of power used for one hour.)

The nation's use of electricity has been steadily on the rise. In 1930 Hawaii's average per capita consumption of electricity was 235 KWH, while in 1975 it was 6,143 KWH, an increase of about 260%. (In 1975, approximately 50% of all electrical energy consumed was for residential use.)

The time may have come when the individual's use of electricity may be limited.

In this activity, students will learn about electricity by using some basic math skills.

1. Discuss and/or review the definition for energy. Introduce and discuss the use of electrical energy in the home.
2. Bring some convenience type appliances and let students guess the wattage on each. Point out that different appliances use different amounts of electricity. Introduce the unit kilowatt-hour (KWH) as a term used to measure consumption of electricity.
3. Distribute Exercise 1.1, "Watt's Used for Power?"
4. Discuss Exercise 1.1. Include in your discussion the fact that our supply of electricity may be limited in the future and may soon affect our life styles. Have them do the follow-up activity.
5. Discuss the follow-up activity after students have completed it.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Do Worksheet 1.1 "Fueling Around".

Exercise 1.1　　Grade Level 9-12

"Watt's Used for Power?"[1]

Background: Oil is brought to Hawaii in ships to make the fire that produces the steam that turns the generators that make the electricity that lights the City of Honolulu.

Let's get an idea of the amount of fuel that is burned.

Oil is unloaded from the ships and stored in huge holding tanks at Iwilei and at Barber's Point. Each tank holds 1.6×10^5 barrels of oil, or just about one-million cubic feet.

Every time a cubic foot of oil is burned, about 1.2×10^5 watt-hours of electricity is produced.

Some Facts About Energy

watt = unit of electrical power $\left(\text{power} = \frac{\text{energy}}{\text{time}}\right)$

kilowatt = 1,000 watts

watt-hour = unit of energy and is equal to the energy supplied by one watt of power in one hour

kilowatt-hour = 1,000 watt-hours (KWH)

1. How many kilowatt-hours of energy can one cubic foot of oil produce?

2. In 1976, the State of Hawaii consumed about 5.62×10^9 KWH of electricity a year. How many cubic feet of oil per year was needed to produce the electricity used in 1976?

3. If the 1976 population of Hawaii was 8.7×10^5, what was the per capita kilowatt-hour consumption per year?

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[1] Adapted from Fuel and Electricity. Office of Instructional Services, Department of Education, Honolulu, Hawaii, July 1972 (unofficial publication).

4. If one of the electric plants on Oahu burns 1.8 x 10^5 gallons of oil a day, or about 25,000 cubic feet, how many kilowatt-hours of electricity does it produce each day? each hour? each year?

5. In 1976, the total electricity consumption for Oahu was 4.8 x 10^9 KWH. Assuming that each plant on Oahu has the generating capacity as the one in problem 4, how many plants were needed to supply the electricity needs for Oahu in 1976?

6. If half of Hawaii's population or approximately 3 x 10^5 persons cut back by using 10 KWH less electricity each year, how many cubic feet of oil would we save? How many gallons would that amount to? (Assume 1 gallon equals 0.14 cubic feet.)

Theme 1. Energy Fundamentals
Worksheet 1.1

Sample Activity 1-1
Grade Level 9-12

"Fueling Around"

Directions: If you were allowed to use only 5,600 kilowatt-hours of electricity each year which of the appliances listed below would you use? Place a check mark (✓) before the appliances that you would use and then add up their kilowatt-hours.

Appliances	Average Kilowatt Hours Used Annually	Kilowatt-Hours of Appliances Chosen
Electric Water Heater	1200	
Refrigerator/Freezer	2400	
Electric Kitchen Range	600	
Toaster	40	
Dishwasher	400	
Stereo	120	
Radio	90	
Color TV	500	
Black & White TV	360	
Vacuum Cleaner	50	
Automatic Clothes Washer	125	
Clothes Dryer	480	
Iron	150	
Room Air Conditioner	1400	
Electric Lights	600	
Electric Clock	20	
Hair Dryer	105	
YOUR TOTAL (must be less than 5,600)		

THEME 1. Energy Fundamentals

Subject Area Math (HEc, LA)
Thematic Area EE
Grade Level 9-12

SAMPLE ACTIVITY 1-2. "Watt's Your Pleasure?"

OBJECTIVE

- To apply laws of science and mathematics to the study of energy.

CONCEPTS

- Energy is the capacity to do work and is subject to natural laws.
- Energy exists in many forms.
- Energy can neither be created nor destroyed but can be converted from one form to another.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 2. Complete commonly used forms.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option X, Level B)

- Adds, subtracts, multiplies, and divides integers. (pg. 124)
- Applies equation-solving techniques to verbal problems. (pg. 124)
- Understands and uses the relationship among common fractions, decimals, and percents. (pg. 124)
- Makes decisions after interpreting data. (pg. 125)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 1.2.
2. Worksheet 1.2.

Sample Activity 1-2
Grade Level 9-12

ACTIVITY (Related Core Themes: 3, 4, 5 & 10)

Americans use enormous amounts of electricity each day. It is so commonplace, many of us hardly give it a second thought. It seems to be always available at the flick of a switch to light our homes, run our kitchen appliances, and provide entertainment through our televisions, and stereos.

Electricity, unlike fossil fuels (oil, gas, or natural gas), cannot be uncovered from earth by drilling or mining. It must be manufactured. Most of our electricity is generated by the burning of fossil fuels. It has been estimated that 16% of our petroleum, 15% of our natural gas, and 46% of our coal is burned to make electricity. In Hawaii, petroleum is used for most of the generation of electricity.

The amount of electricity we use is measured in kilowatt-hours (KWH). A kilowatt-hour is equivalent to the energy used when a device rated 1,000 watts operates for an hour (or a 100-watt appliance operates for 10 hours). In 1958, the average home in Hawaii used 3,916 KWH per year. In 1976, the average home in Hawaii used 7,543 KWH per year. (Information from the Department of Energy.) Until recently our supply of electricity seemed limitless. Today with the "energy crisis," our limitless supply of electricity may be in jeopardy. We can no longer be assured of all the electric power we need if we continue to rely on fossil fuels alone. We need to increase our research and development efforts in search of alternate, renewable, sources of energy.

In this activity, students will use mathematical skills while learning about electricity and its use in the home.

1. Discuss the present energy situation with the students. Ask students the following:
   (a) How do you use energy each day?
   (b) What kinds of energy do you use?
   (c) What form of energy is most frequently used at home?
2. Next, distribute Exercise 1.2 and discuss briefly electricity and how the amount of electricity used is measured.
3. After students have completed the exercise, have them do Worksheet 1.2.
4. Now that students are familiar with some costs associated with the operation of electrical appliances, discuss the following questions:
   (a) Which appliances would you be willing to do without?
   (b) Are there any appliances that you could not do without? Why?
   (c) Which electrical appliance is the biggest energy hog in your house?
   (d) If you had to cut back electrical consumption by 20%, what would you be willing to do?

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Using the "Annual and Daily KWH Use for Various Electrical Appliances," create your own problems for fellow classmates to solve. Post them on the bulletin board under the heading: Energy Challenges.

Sample Activity 1-2
Grade Level 9-12

"Watt's Used?"

Background: The basic unit of power is the watt. For any electrical appliances, the wattage (power rating) is found by multiplying voltage (volts) by current (amperes). For example, a 200-volt appliance drawing a current of 10 amperes has a power rating of 2000 watts. A kilowatt is 1000 watts and a megawatt is a million watts. One horsepower is equivalent to 746 watts.

The basic unit for the amount of electricity used is the kilowatt-hour (KWH) which is the amount of energy used by a 1000 watt device operating for one hour. For example, a 2000 watt appliance operating for 2 hours uses 4 KWH of energy.

PART I: Consumption of Electricity

Directions: Using the "Annual and Daily KWH Use For Various Electrical Appliances" chart, do the following problems.

1. If the toaster is used 15 minutes a day, how many KWH will it use in a week? A month? A year? Write your answers on the chart.

2. What is the current (amperage) used by the electric fry pan if the voltage used is 120 volts? (Hint: Using the information on the chart, first calculate wattage for the electric fry pan.) Write your findings on the chart.

3. A color television is on for 3 hours a day and the stove for 30 minutes. Which electrical appliance is using more energy? How much more?

4. If the clothes dryer is used 240 hours annually, what is the daily hours of operation? Write your answer on the chart.

5. Calculate the annual cost of electricity for the range, if electricity costs 6.4¢ per kilowatt-hour. what would the daily cost of operating the range be?

6. The food mixer is used 12 minutes each day and consumes 0.02 KWH of energy. Calculate the wattage of the mixer. Write your answer on the chart.

7. The blow dryer is used 15 minutes a day and incurs an annual operating cost of $7.00. What is the wattage of the blow dryer if the electricity rate is $.064 per kilowatt hour?

Theme 1. Energy Fundamentals Sample Activity 1-2

Exercise 1.2 (Cont'd.) Grade Level 9-12

PART II: Electricity Use Equivalents

Directions: Given the following information, solve problems 8-10.

ENERGY FACTS	
Unit or Process	Number of KWH
calorie (food)	1.2×10^{-3}
calorie	1.2×10^{-6}
British Thermal Unit	2.9×10^{-4}
1 hour manual labor	6.0×10^{-2}
Combustion of 1 gallon of gasoline	3.83×10^{1}
Heating 1 gallon of water 1°F	2.4×10^{-3}

8. Calculate the KWH equivalent of driving an automobile at 88 kilometers/hour (55 miles/hour) for one hour if the fuel economy of the car is 6.5 kilometers per liter? How long would this amount of energy operate a 200-watt bulb?

9. If a man worked 8 hours a day, 5 days a week, for one year, how many kilowatt of energy would he expend? How many 40 watt-fluorescent lights could burn for 2 hours if we could convert the energy he expended into electricity?

10. How long will it take a 20-amp, 220-volt hot water heater to heat 50 gallons of water from 60°F to 140°F?

Theme 1. Energy Fundamentals — Sample Activity 1-2

Exercise 1.2 - "Watt's Used?" — Grade Level 9-12

Annual and Daily KWH Use for Various Electrical Appliances

APPLIANCE	AVERAGE WATTS	ANNUAL HOURS OF OPERATION	DAILY HOURS OF OPERATION	ANNUAL KWH USE	DAILY KWH USE
Clothes Dryer	4600	240			
Coffee Maker	800	180	0.5	145	0.40
Dishwasher 2/	1200	360	1	430	1.18
Food Blender	350	36	0.1	125	0.34
Food Freezer - 15 cu. ft.					
Standard	350	3425	7.4	1200	3.29
Frost Free	440	4000	11	1760	4.82
Food Mixer					
Food Waste Disposer	450	65	0.2	30	0.08
Fry Pan		300	0.8	345	0.91
Blow Dryer			0.25		
Iron	1100	145	0.4	160	0.44
Radio					
Console	75	1400	3.8	105	0.29
Table	50	1400	3.8	70	0.19
Range	12000	100	0.27	1200	3.29
Self Cleaning Oven	4000	50	0.14	200	0.55
Record Player					
Console	160	300	0.8	50	0.14
Table	75	300	0.8	25	0.07
Recorder	100	100	0.27	10	0.03
Refrigerator-Freezer - 14 cu. ft.					
Standard	325	3540	9.7	1250	3.42
Frost Free	360	5150	14.1	1850	5.07
Sewing Machine	100	120	0.33	12	0.03
Television					
Black and White	240	1500	4.1	360	0.99
Color	350	1500	4.1	525	1.44
Toaster	1150		0.25		
Toothbrush	5	10	0.03	1/	
Vacuum Cleaner					
Portable	210	60	0.16	13	0.04
Standard	600	120	0.33	70	0.19
Waffle Iron	1100	24	0.07	26	0.07
Washer 2/					
Automatic	500	200	0.55	100	0.27
Nonautomatic	285	200	0.55	75	0.21
Water Heater (varies considerably with clothes washing and bathing habits)	2475-4475				13.15-26.30

1/ Less than 1 KWH

2/ Does not include electricity to heat water.

NOTE: These uses are those calculated for an average family of four for an average number of hours.

Theme 1. Energy Fundamentals

Worksheet 1.2

Sample Activity 1-2

Grade Level 9-12

"The Price of Luxury"

Directions:
1. Do an inventory of 5 electrical appliances in your home.
2. List 5 appliances and their wattages in the spaces below and keep a log of the number of hours the appliance was in operation each day. (See Column 3.)
3. Based on your weekly log, calculate the annual hours of operation, kilowatt-hours, and cost of operation for each appliance.

Appliance	Wattage	Daily Hours of Operation							Annual Hours of Operation	Annual KWH Use	Annual Cost of Operation*
		Su	M	T	W	Th	F	Sa			
1.											
2.											
3											
4.											
5.											

*Assume the following costs per kilowatt-hour (KWH): Oahu = $.064; Maui = $.089; Lanai = $.095; Hawaii = $.088; Kauai = $.12; and Molokai = $.12. (Based on costs--July 1980.)

THEME 1. Energy Fundamentals

Subject Area Math (Sc)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 1-3. "You Light Up My Life"

OBJECTIVE

- To apply the laws of science and mathematics to the study of energy.

CONCEPTS

- All living things and natural processes require energy.
- The sun is the basic source of energy on earth.
- Energy exists in many forms.
- Energy can be neither be created nor destroyed but can be converted from one form to another.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 10. Use resources for independent learning.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Core Geometry)

- Is aware of the notion of "similar figures." (pg. 131)
- Uses ratio and proportion to solve problems involving similarity. (pg. 131)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 1.3.
2. Ruler, cardboard, straight pin.

Sample Activity 1-3

Grade Level 9-12

ACTIVITY (Related Core Themes: 2, 6, & 15)

The sun is the basic source of energy on earth. As the sun's rays reach the earth, they warm the air causing it to move and produce wind. The sun also causes water to evaporate, which later falls as rain that feeds streams and rivers. The energy of flowing waters can be harnessed to perform useful work.

The sun's energy is also captured and stored by plants through a process called photosynthesis. Plants help to provide the food energy that starts the food pyramid.

Like the energy found in wind, food, and water, fossil fuel energy can also be traced back to the sun. Fossil fuels are really decayed plant and animal matter that have been changed by heat and pressure over millions of years.

The knowledge that the sun was a source of energy can be traced as far back as the clay tablet era in Mesopotamia. During those days, temple priestesses used polished golden vessels to focus the rays of the sun and thereby ignite the altar fires. Many other solar energy devices have been found, dating back as early as the fifteenth century B.C.

Over the past 10 years, a renewed interst in the sun as a potential source of energy for our daily life's chores has emerged. With usable sources of energy dwindling, the energy generated by the sun may be one of the answers.

In this activity students will be learning more about the sun using principles of geometry.

1. Discuss and/or review with the students the definition of energy.
2. Discuss why the sun is considered to be the basic source of energy on earth.
3. Have students guess how much energy reaches the earth. How big is the sun anyway?
4. Have students do Exercise 1.3 to find out how big the sun really is.
5. After students have completed the exercise, have them compare their findings with data given in a science sourcebook such as The Handbook of Physics and Chemistry. (Note to the teacher: The diameter of the sun is approximately 864,000 miles or 1,380,000 kilometers.)
6. Have students find out more about the sun. (See Follow-up/Assessment Activities section on the next page.)

Sample Activity 1-3

Grade Level 9-12

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

1. Through research, calculate the percentage of heat energy emanated by the sun that reaches the earth. Consult a scientific source such as The Handbook of Physics and Chemistry.
2. Devise a means of increasing the amount of solar energy reaching earth. Test out your ideas.

Exercise 1.3 Grade Level 9-12

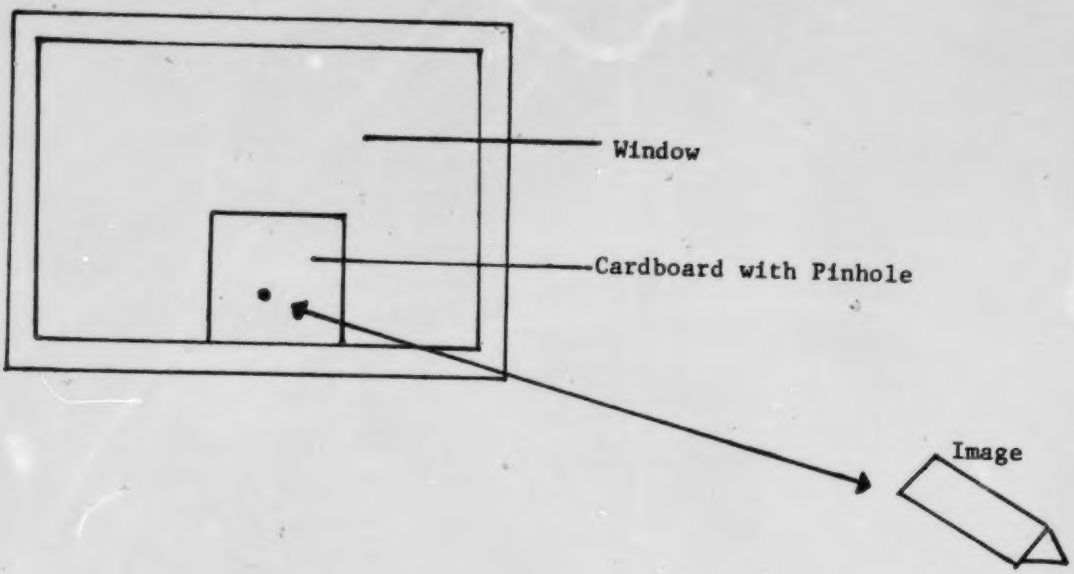
"You Light Up My Life"

Problems: Using the principle of similar triangles, calculate the radius, diameter, and area of the sun.

Directions:

1. Make a pinhole through a piece of cardboard.
2. Select an area in the room facing the sun. Darken the room as much as possible.
3. Place the cardboard on the window. (Pinhole on the cardboard should be large enough to allow some sunlight through.)
4. "Capture" the sun's image using a screen (such as a cardboard or stiff paper) held parallel to the window (or the cardboard with the pinhole). Adjust the screen until the image is visible and clear. (See Diagram A.)

Diagram A

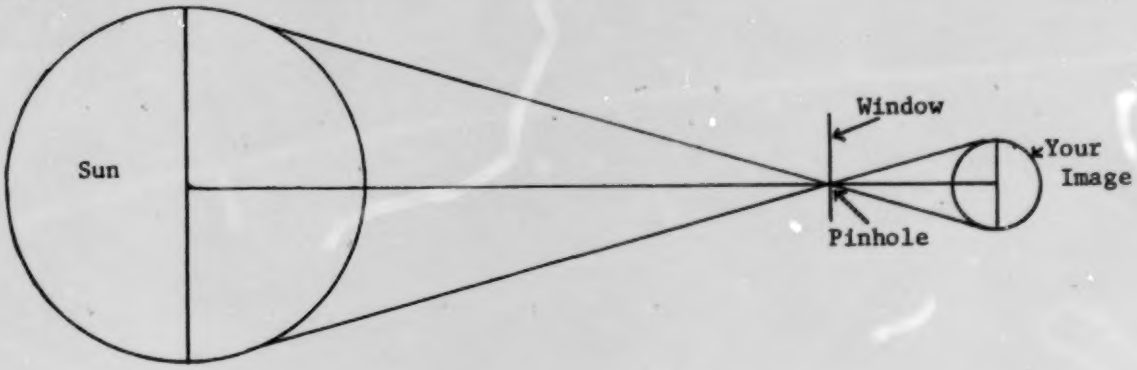


5. Measure the diameter of the sun's image on the screen.

6. Measure the distance from the screen to the cardboard with the pinhole (or the window).

7. Using the principles of similar right triangles and congruency, determine the radius, diameter and area of the sun. (See Diagram B.) (Hint: The sun is 93,000,000 miles away from Earth.)

Diagram B



(Note: Not drawn to scale)

8. State the theorems and/or postulates and/or corollaries used.

51

THEME 2. EVOLUTION OF ENERGY

BACKGROUND

In this theme, history is interpreted in terms of the level of energy-conversion technology in relation to the evolution of energy consumption. The discovery, development and consumption of energy resources in different cultures are traced over thousands of years. This theme also indicates that energy consumption evolved from initially meeting basic needs of humans to later satisfying "wants" of industrialized societies as well.

The historical perspective of this theme will enable students to appreciate the essence of energy in the lives of humans and the primary role energy has played in shaping the history of western civilization and the world. It will also help them to recognize some of the societal problems and benefits created by the growth of science and technology.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 4. Develop independence in learning.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To understand the historical development of sources and uses of energy.

CONCEPTS

1. History can be interpreted in terms of the discovery, development, and use of energy sources ranging from human power to fossil fuels.
2. Energy use evolved from meeting basic needs of primitive cultures to satisfying "wants" of highly industrialized societies.
3. Energy-conversion technology evolved to make more efficient use of energy sources to perform useful work.
4. The development of energy-conversion technology affected and was affected by the growth of differing societal, governmental, political, economic, and cultural systems.
5. Hawaii's history of energy use shows a movement from dependence entirely on local sources of energy to dependence on energy sources outside Hawaii.

THEME 2. Evolution of Energy

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 57 - Unit V) Technical advancement permits larger volume production systems and requirements.

ART: (pg. 7 - Objective) Acquire knowledge of and an appreciation for people's cultural heritage by exposure to and discussion about works of art from many cultures and times.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 5 - Goal) To develop an understanding of the literary, historical and cultural heritage of the people whose language is studied.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To develop the ability to cope with change.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HOME ECONOMICS: (pg. iii - Objective) Develop mutual understanding and appreciation for differing cultures and ways of life, and cooperate with people of other cultures who are striving to raise levels of living.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an appreciation of the human-made world and the products of a managed-production system which satisfy the needs and wants of people.

LANGUAGE ARTS: (pg. 4 - Goal) To enrich and extend student experiences and understanding of literature.

MUSIC: (pg. 2 - Objective) Compare and analyze music of various historical periods and styles.

SCIENCE: (pg. A-13 - Objective) Foster the students' appreciation for the practical and aesthetic contribution of science to the improvement of the quality of life and to promote in our students the desire to take an active part in that contribution.

SOCIAL STUDIES: (pg. 11 & 12 - Objectives) 1. The student knows historically-documented facts about people, places, events, inventions, institutions, etc., of traditional or practical significance to communities of which he or she is a member. 2. The students knows scientifically validated facts about the social, political, and economic behavior of humans and human organizations in a variety of times and environments. 3. The student values contributions of history and the social sciences to his or her growing philosophy with regard to self, others, and the environment.

THEME 3. ENERGY TODAY

BACKGROUND

In theme 3, students examine and evaluate the current sources and uses of energy for the purpose of understanding how deeply the use of energy permeates their daily lives. They also investigate the ways in which modern technological society uses energy to support the conveniences of home, transportation, industry and commerce. The energy used by modern societies amounts to more than 100 times as much as primitive cultures used in the past.

While keeping the increasing demand for energy in mind, students become aware that energy resources are becoming scarce and costly. They also become aware of the need for wise and efficient use of energy sources.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 6. Recognize and pursue career development as an integral part of growth and development.

CORE THEME OBJECTIVE

To know current sources and uses of energy.

CONCEPTS

1. The available energy sources fall into two basic categories: renewable and non-renewable.
2. The major energy sources we use today are fossil fuels which are limited and non-renewable.
3. The major uses of energy are industrial, transportational, residential, and commercial.
4. The availability of energy sources affects and is affected by technology and by political, social, economic and cultural systems.
5. Hawaii imports almost all of its materials and energy sources from outside the state.

THEME 3. Energy Today

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 58 - Unit VI) Efficient processing, marketing, and distribution are essential in making agricultural products economically available to people.

ART: (pg. 7 - Objective) Make and justify judgments about works of art and the selection of art products used in daily living.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) An understanding of the geographic influences upon the economic and social development of the country.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HEALTH: (pg. 1 - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experience contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Make and carry out intelligent decisions regarding the use of personal, family, and community resources.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an understanding of the nature and significance of materials, tools, processes, products and occupations of our technological world, and their impact upon our society.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop mathematical competencies to function effectively in today's society.

MUSIC: (pg. 2 - Objective) Use musical skills in communicating ideas, thoughts and feelings.

PHYSICAL EDUCATION: (pg. 106 - Objective) Acquire the habit of participating in wholesome recreational activities.

SCIENCE: (pg. A-13 - Objectives) 1. Facilitate the students' ability to use scientific knowledge, processes, instruments and scientific language to clarify values, examine issues, solve problems in fulfilling personal, social and career life roles. 2. Foster the intellectual virtues that are characteristics of science inventiveness, self-direction, and rationality. 3. Help students to analyze and synthesize holistically (using knowledge from various disciplines) in solving a problem.

SOCIAL STUDIES: (pg. 11 - Objectives) 1. The student is able to select and use appropriate criteria, procedures, and information sources to assess the validity or significance of findings about past, present, or future human life or affairs. 2. The student is able to identify and analyze problems and issues by which he or she is affected as a member of a changing multicultural society.

THEME 3. Energy Today

Subject Area Mathematics

Grade Level 9-12

THINGS TO DO[1]

*1. Find out what sources of energy Hawaii depends on. What percent of our energy comes from waste materials? (See Sample Activity 3-1. "Fuels Rush In.")

*2. What is the average monthly kilowatt-hour consumption of electricity for a family of 6? Find out what percent of a family's electrical consumption is for lighting. (See Sample Activity 3-2. "A Part of Watt?")

*3. Find out Hawaii's energy consumption by economic sectors. What percent of the total energy consumed is for transportation? (See Sample Activity 3-3. "Energy Eaters.")

*4. Investigate the relationship between energy consumption and population growth. (See Sample Activity 3-4. "There's No Fuel Like an Old Fuel.")

5. Calculate the percentage of the world's oil, coal, and natural gas owned by the United States and the percentage of the world's output we actually use.

6. Determine the stock market activities for the last three years for two to four companies that produce energy products. Make a graph of your findings.

VOCABULARY

Allocation of resources, barrel, crude oil, economic sectors, fossil fuels, fuels, imports, kilowatt, kilowatt-hour, non-renewable, OPEC, per capita, renewable, scarcity, wants, watt, watt-hour.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Ecoscience: Population, Resources, Environment by Paul and Anne Ehrlich and John Holdren. W.H. Freeman and Co., San Francisco, California, 1977.

b. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.

c. Energy Use in Hawaii. Department of Planning and Economic Development, State Energy Office, State of Hawaii, November 1977.

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* For detailed description, refer to noted Sample Activity.

THEME 3. Energy Today

Subject Area Math (LA, Sc, SS)
Thematic Area EE, G, LS, VE
Grade Level 7-8

SAMPLE ACTIVITY 3-1. "Fuels Rush In"

OBJECTIVE

- To know current sources and uses of energy.

CONCEPTS

- The available energy sources fall into two basic categories: renewable and non-renewable.
- The major energy sources we use today are fossil fuels which are limited and non-renewable.
- The major uses of energy are industrial, transportational, residential, and commercial.
- The availability of energy sources affects and is affected by technology and by political, social, economic and cultural systems.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will demonstrate their awareness of population processes and dynamics. (Goal: pg. D23)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES

- Rounds numbers to a designated value. (pg. 95)
- Adds, subtracts, multiplies, and divides whole numbers. (pg. 96)
- Adds, subtracts, multiplies, and divides decimals. (pg. 98)
- Solves percent problems. (pg. 98)
- Extends ability to read, interpret, and make graphs and tables. (pg. 101)

Theme 3. Energy Today

Sample Activity 3-1

Grade Level 7-8

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 3.1.
2. Worksheet 3.1.

Theme 3. Energy Today

Sample Activity 3-1

Grade Level 7-8

ACTIVITY (Related Core Themes: 2, 4, 5 & 12)

The United States is the most energy-intensive society in the world. Americans use about 75 quadrillion BTU's a year which is equivalent to about 13 billion barrels of oil. (A barrel of oil contains 42 gallons.) In other words, Americans consume an equivalent of 412 barrels of oil every second. However, only half of the energy comes from oil, the other half comes from natural gas , coal, hydroelectric and nuclear. Hawaii residents get most of their energy (about 90%) from oil, a non-renewable fossil fuel. Because fossil-fuel energy is dwindling, research and development of new and/or renewed sources is needed to assure future generations of an adequate supply.

This activity will enable students to use their graphing skills while learning about energy sources and consumption.

1. Discuss the present energy situation with the students. How do we get our energy? Where do we get it from? How much do we use?
2. Next, distribute Exercise 3.1 and have them do the exercise.
3. After they have completed the exercise, discuss each problem.
4. As a review of graphing skills, have them do Worksheet 3.1.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Select 5 countries and compare the average per capita energy consumption. Draw a graph to illustrate the differences of per capita energy consumption among the various countries. (One good sourcebook is *Ecoscience: Population, Resources, Environment* by Paul and Anne Ehrlich and John Holdren.)

Theme 3. Energy Today

Sample Activity 3-1

Exercise 3.1

Grade Level 7-8

"Fuels Rush In"

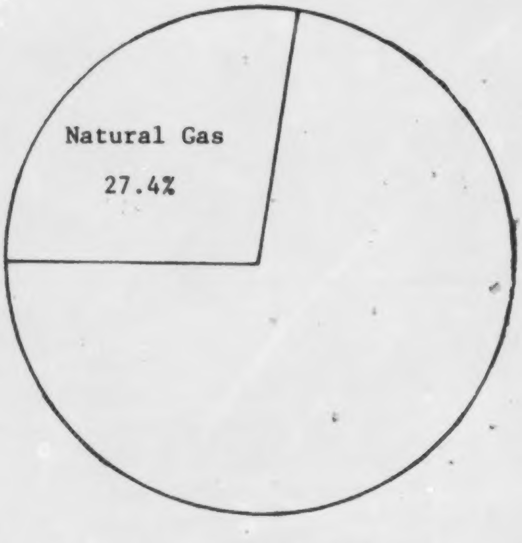
Directions: Solve each of the problems below.

1. Using the data from Table 1, "Sources of Energy," complete the circle graphs below.

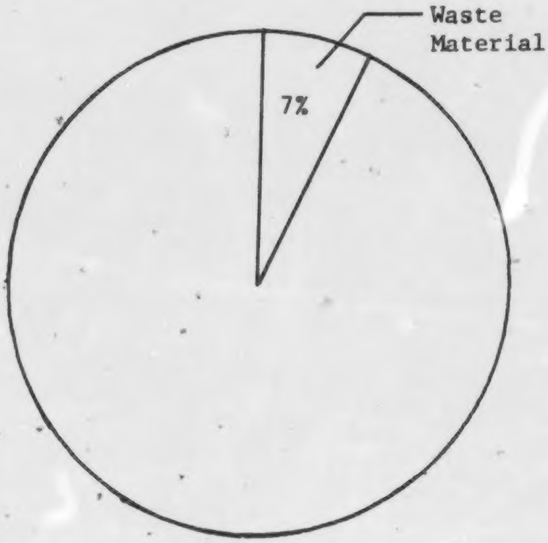
Table 1. Sources of Energy, 1976

Location	Source of Energy Used in 1976 (in percent)					
	Petroleum	Natural Gas	Coal	Hydo-electric	Nuclear Power	Waste Material
U. S. A.	47.3	27.4	18.4	4.1	2.8	--
Hawaii	92.0	--	--	1.0	--	7.0

Data from Energy Use in Hawaii, Department of Planning and Economic Development, State Energy Office, Honolulu, Hawaii, November 1977, pg. 4.



U.S.A. - Sources of Energy (1976)



Hawaii - Sources of Energy (1976)

2. Since Hawaii has no fossil-fuels (coal, oil and natural gas) it must import all of its fossil-fuel needs. What percentage of Hawaii's energy needs are derived from fossil fuels? What percentage is imported?

Theme 3. Energy Today | Sample Activity 3-1

Exercise 3.1 - "Fuels Rush In" (Cont'd.) | Grade Level 7-8

3. In 1976, what percentage of all energy used in the U.S.A. was produced from fossil fuels? What percentage was produced from rivers and dams?

4. Draw a line graph using the information given in Table 2, "U.S.A. Energy Consumption per Capita."

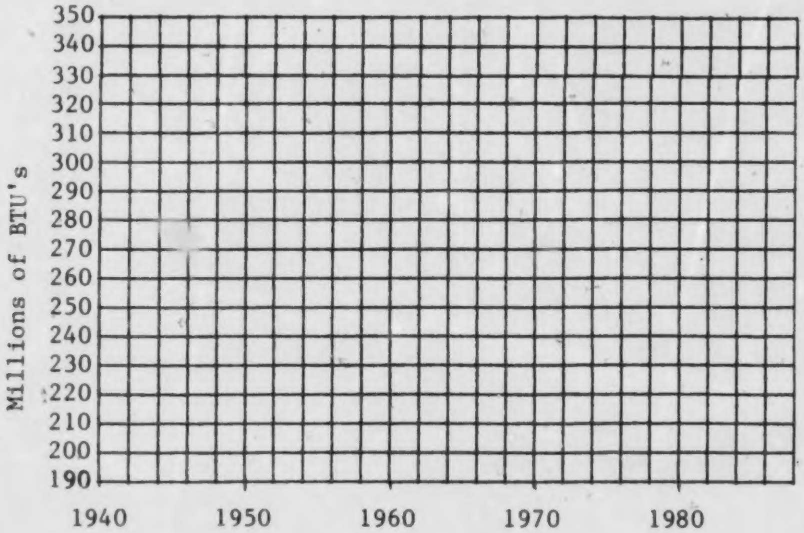
Table 2. U.S.A. Energy Consumption Per Capita*

Year	1940	1950	1960	1970	1971	1972	1973	1974	1975
Millions of BTU	190	232	247	329	333	345	355	334	333

100 million BTU is the equivalent of 18 barrels of petroleum.

Source: U.S. Department of the Interior, Energy Perspectives, Feb. 1975, pg. 42, (1850-1973); U.S. Department of Commerce, Bureau of Census, U.S.A. Statistics in Brief 1976: A Statistical Abstract Supplement, "Energy and Science," (1974-1975).

*Data rounded off to the nearest whole number.



5. How many barrels of petroleum were consumed by each person in 1940? in 1950? in 1960? in 1975? (Hint: first find out how many barrels of petroleum 1 million BTU's are equivalent to.)

6. Look at your graph. Was there a steady increase of energy use from 1940 to 1975? Explain. What accounts for the slight decline between 1973 and 1975?

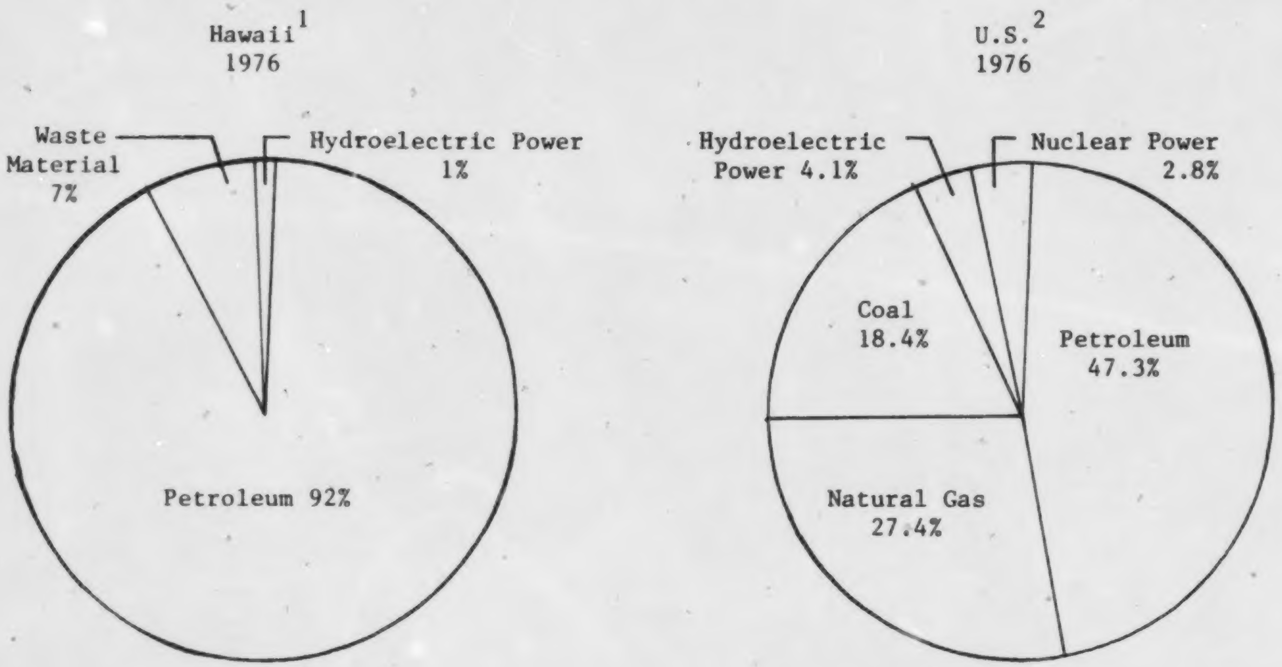
7. The population of Hawaii in 1975 was 868,400. If energy consumption remained the same from 1973 to 1975, what would have been the total energy consumption in BTU's for Hawaii in 1976? What was the actual consumption, based on the data in Table 2? How many BTU's were conserved by Hawaii residents in 1975?

8. If each individual cuts down his or her annual consumption by 10% of what that person used in 1972, how many millions of BTU would each conserve? How many barrels of petroleum would that be?

Theme 3. Energy Today
Exercise 3.1 - "Teacher's Answer Sheet"

Sample Activity 3-1
Grade Level 7-8

"Sources of Energy"



[1] State Energy Office estimates (Hawaiian Sugar Planters Assoc., Army Corps of Engineers)

[2] U.S. Bureau of Mines

Note: Percent of total usage in equivalent barrels.

Theme 3. Energy Today

Sample Activity 3-1

Worksheet 3.1 - "Energy Graphics"

Grade Level 7-8

Directions:
1. Number the "x" axis of the graph paper from 0 to 15.
2. Number the "y" axis from 0 to 20.
3. Plot each set of coordinates and connect each one as you proceed to the previous one.
4. When the word "lift" appears, lift your pencil and plot the next set of coordinates but do not connect it to the previous one.
5. Continue to plot all points and when you have completed the graphing, a picture will appear.

x	y
2	18 1/4
6	18 1/4
6	11 3/4
2	11 3/4
2	18 1/4
1 3/4	18 1/4
1 3/4	18
6 1/4	18
6 1/4	18 1/4
6	18
LIFT	
2	11 3/4
1 3/4	11 3/4
1 3/4	12
6 1/4	12
6 1/4	11 3/4
6	11 3/4
LIFT	
2	17 1/8
1 7/8	17
2	16 7/8
6	16 7/8
6 1/8	17
6	17 1/8
LIFT	
1 7/8	17
6 1/8	17
LIFT	
2	13 1/8
1 7/8	13
2	12 7/8
6	12 7/8
6 1/8	13
6	13 1/8
LIFT	

x	y
1 7/8	13
6 1/8	13
LIFT	
2 1/2	15 1/2
2 1/2	14 1/2
3 1/2	14 1/2
3 1/2	15 1/2
2 1/2	15 1/2
LIFT	
4 1/2	15 1/2
4 1/2	14 1/2
LIFT	
5	15 1/2
5	14 1/2
5 3/4	14 1/2
LIFT	
10 3/4	18
10 3/4	17
10 1/2	16
9 3/4	15
9 1/4	14
9	13 1/2
8 1/2	12
8 1/2	11 1/2
8 3/4	11
9 1/4	10 1/2
10 1/2	9 1/2
11 1/4	10
12	11
12 1/2	12
12 1/2	13
12 1/2	14
12 1/4	15
11 3/4	16
11 1/2	17
10 3/4	18
LIFT	

x	y
11	15
10 3/4	14 1/2
10 1/2	14
9 3/4	13
9 1/2	12
9 1/4	11 1/2
9 1/2	10 1/2
10 1/2	9 1/2
11	10
11 1/2	10 3/4
11 3/4	11
11 3/4	12
11 3/4	13
11 1/2	14
11	15
LIFT	
10 3/4	13
10 1/2	9 1/2
11	10 3/4
11	12
10 3/4	13
LIFT	
9 1/2	9
8 3/4	9
8 3/4	8
9 1/2	8
9 1/2	8 1/2
LIFT	
9 1/4	8 1/2
9 3/4	8 1/2
LIFT	
10	8
10 1/2	9
11	8
LIFT	

x	y
10 1/4	8 1/2
10 3/4	8 1/2
LIFT	
12 1/4	9
11 1/2	9
11 1/2	8 1/2
12 1/4	8 1/2
12 1/4	8
11 1/2	8
LIFT	
6	7
5	6
5	5
5	4
4	4
3 1/2	3 1/2
3 1/2	3
3 1/4	2 1/2
4	2 1/2
4 1/2	2 3/4
5	2 3/4
5 1/2	2 1/2
6	2 1/2
7	2 1/2
8	2 3/4
9	2 1/2
10 1/2	2 1/2
9 1/2	3 1/2
9 1/4	4 3/4
9	5
8	5 1/2
7 1/2	5
7	6 1/4
6	7
LIFT	

Theme 3. Energy Today Sample Activity 3-1

Worksheet 3.1 (Cont'd.) Grade Level 7-8

x	y
5	6
6	5
6 1/2	5
7	6 1/4

LIFT

x	y
5	5
6	4
6 1/2	4 1/4
7	4 1/2
7 1/2	5

LIFT

x	y
6	5
6	4

LIFT

x	y
6 1/2	5
6 1/2	4 1/4

LIFT

x	y
6 1/4	6 1/2
5 3/4	5 3/4

LIFT

x	y
6 1/2	6 1/4
6	5 1/2

LIFT

x	y
7	4 1/2
8	4
9	4
9	5

LIFT

x	y
8 1/4	5
7 3/4	4 1/2

LIFT

x	y
8 3/4	4 3/4
8 1/4	4 1/4

LIFT

x	y
4 1/2	3 3/4
5	3 1/2
7	3 1/2
8	3
9	4

LIFT

x	y
6	4
5 1/2	3 1/2

LIFT

x	y
8	4
7	3 1/2

LIFT

x	y
9	4
9 1/2	3 1/2

LIFT

x	y
4 1/4	3 1/2
3 3/4	2 3/4

LIFT

x	y
4 1/2	3 1/2
4 1/4	2 3/4

LIFT

x	y
5 3/4	3 1/4
5 1/2	2 3/4

LIFT

x	y
6 1/4	3 1/4
6	2 3/4

LIFT

x	y
6 3/4	3 1/4
6 1/2	2 3/4

LIFT

x	y
8 3/4	3 1/2
8 1/2	2 3/4
9 1/4	3 1/2
8 3/4	2 3/4

LIFT

x	y
9 1/2	3 1/4
9 1/4	2 3/4

LIFT

x	y
5	2
4 1/4	2
4 1/4	1
5	1

LIFT

x	y
5 3/4	2
5 3/4	1
6 1/2	1
6 1/2	2
5 3/4	2

LIFT

x	y
7	1
7 1/2	2
8	1

LIFT

x	y
7 1/4	1 1/2
7 3/4	1 1/2

LIFT

x	y
8 1/2	2
8 1/2	1
9 1/4	1

Theme 3. Energy Today

Sample Activity 3-1

Worksheet 3.1 - "Energy Graphics" (Cont'd.)

Grade Level 7-8

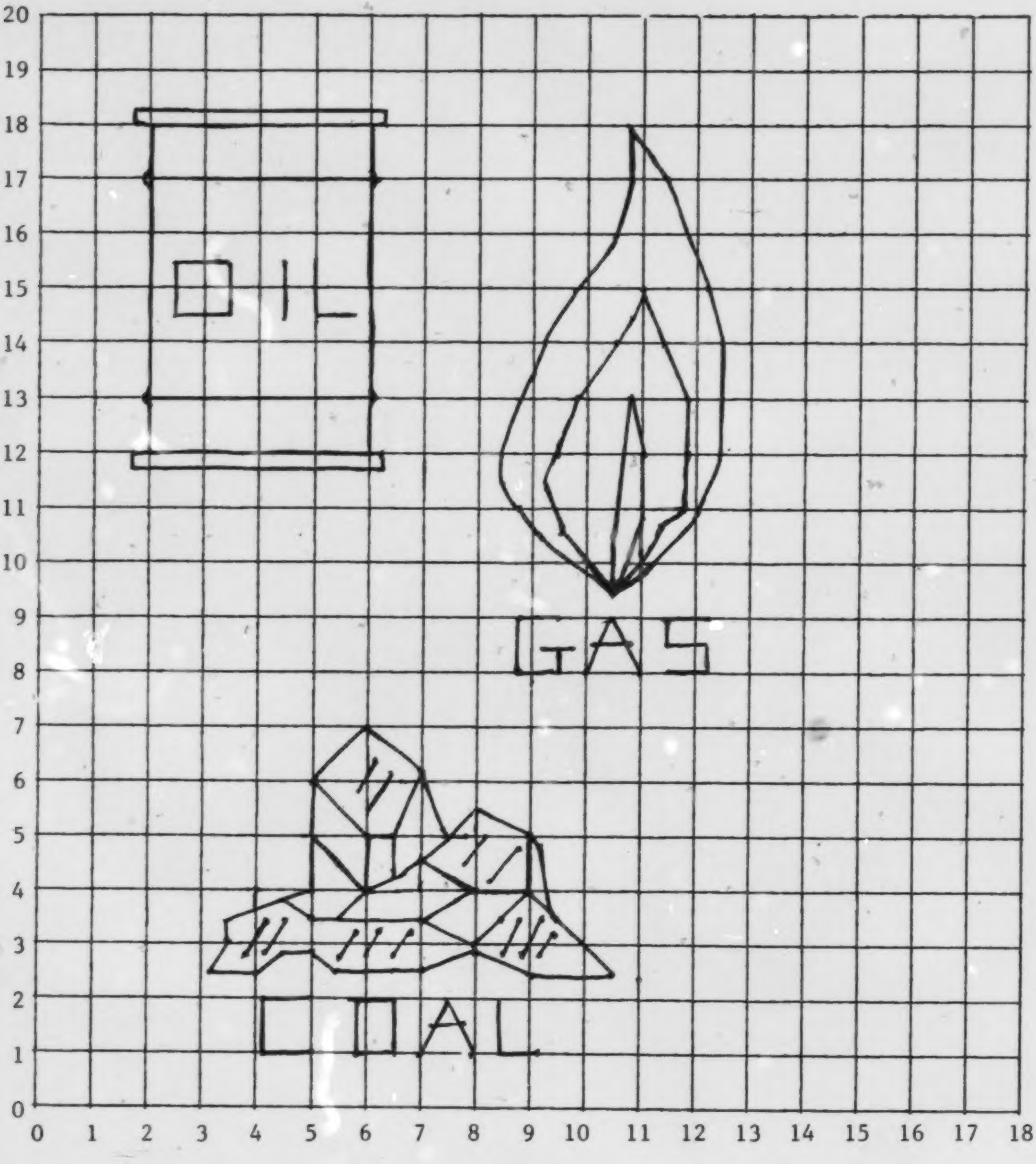
This "energy graphics" represent _ _ _ _ _ _ _   _ _ _ _ _

Theme 3. Energy Today

Sample Activity 3-1

Worksheet 3.1 - "Energy Graphics"
Teacher's Answer Sheet

Grade Level 7-8



This "energy graphics" represent F O S S I L F U E L S

THEME 3. Energy Today

Subject Area Math (BPA, HEc, Sc, SS
Thematic Area EE, G, LS, VE
Grade Level 7-8

SAMPLE ACTIVITY 3-2. "A Part of Watt?"

OBJECTIVE

- To know current sources and uses of energy.

CONCEPTS

- The available energy sources fall into two basic categories: renewable and non-renewable.
- The major energy sources we use today are fossil fuels which are limited and non-renewable.
- The major uses of energy are industrial, transportational, residential, and commercial.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 14. Demonstrate knowledge of the citizen's opportunities to participate in political processes.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 3. Energy Today

Sample Activity 3-2

Grade Level 7-8

MATHEMATICS PROGRAM LEARNER OBJECTIVES

- Adds, subtracts, multiplies, and divides whole numbers. (pg. 96)
- Understands and uses ratios and proportions. (pg. 98)
- Understands and uses the relationship among common fractions, decimal fractions, and percents. (pg. 98)
- Solves percent problems. (pg. 98)
- Uses appropriate tools and units to measure objects. (pg. 100)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 3.2.
2. Worksheet 3.2.

69

Sample Activity 3-2

Grade Level 7-8

ACTIVITY (Related Core Themes: 1, 4, 5, 7 & 10)

Most of the energy used by island residents is for electricity. According to the State Energy Office data, approximately 60% of the energy consumed by local residents is for electricity. The biggest energy consumer in the home is the electric water heater which consumes about 30-40% of the electrical energy used in the home. A typical family of 6 consumes about 18,430 KWH of electricity annually. Studies indicate that Hawaii residents' use of energy in their home and their car account for about one-fourth of all energy consumed in the state. An average person living in the continental U.S.A. uses 32% of the total energy consumed.

In this activity, students will practice skills in percent as they learn about electrical consumption in the average island home.

1. Discuss and/or review the definition of energy with students. Center the discussion around the energy used by students each day--electricity.
2. Discuss how electrical consumption is measured and what unit is used.
3. Distribute Exercise 3.2.
4. After students have completed the exercise, discuss the questions with the students.
5. For a review of percents, have students do Worksheet 3.2.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Conduct an energy audit of your home. Record the amount of KWH used each day. How can you find out how much is used in a week? In a month? In a year?

Theme 3. Energy Today

Exercise 3.2

Sample Activity 3-2

Grade Level 7-8

"A Part of Watt?"

Directions: Using the information from Table 1, "Residential Use of Energy", do the following problems. Express your answers to the nearest tenth percent.

1. For a typical family of 6 living in a large family home, what is the average monthly kilowatt-hour (KWH) consumption of electricity? What is the average monthly consumption for a family of 3 living in a 2 bedroom condominium?

2. What percent of total electrical consumption is used for the lighting systems for a large family of 6? Family of 3?

3. Which family uses a larger percentage of their total KWH consumption for the electric water heater? How much more?

4. Compare the percent of KWH used by the family of 6 for a small color TV and the percent of electricity used by the family of 3 for a stereo. Which family uses a larger portion of their monthly KWH consumption to operate the given appliance?

5. If the family of 6 does not have a pool pump, what would their total monthly KWH consumption be? What would the percentage of KWH be for the water heater now? For lighting?

Table 1. Residential Use of Energy
(Typical Monthly Consumption)[1]

Type of Load	Large Family Home (6 Members)	Two Bedroom Condo. (3 Members)*
	KWH	KWH
Total	2,000	750
Lighting	100	65
Frost free refrigerator (24 cu. ft.)	250	
19 cu. ft.		
13 cu. ft.		125
Electric water heater	600	300
Electric cooking	150	75
Electric dryer	120	80
Clothes washer	15	10
Frost free freezer (15 cu. ft.)	150	
Air conditioner (1,000 watt)	125	
Dishwasher	40	25
Color TV (large)	55	
Color TV		30
Color TV (small)	25	
Stereo/radio	10	10
Pool pump (1 HP, 10 hours per day)	300	
Miscellaneous	60	30

*/ Includes individual electric water heater.
Source: Hawaiian Electric Company, Inc., 1976.

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[1] Data from Energy Use in Hawaii. Department of Planning and Economic Development, State Energy Office, State of Hawaii, Honolulu, Hawaii, November, 1977.

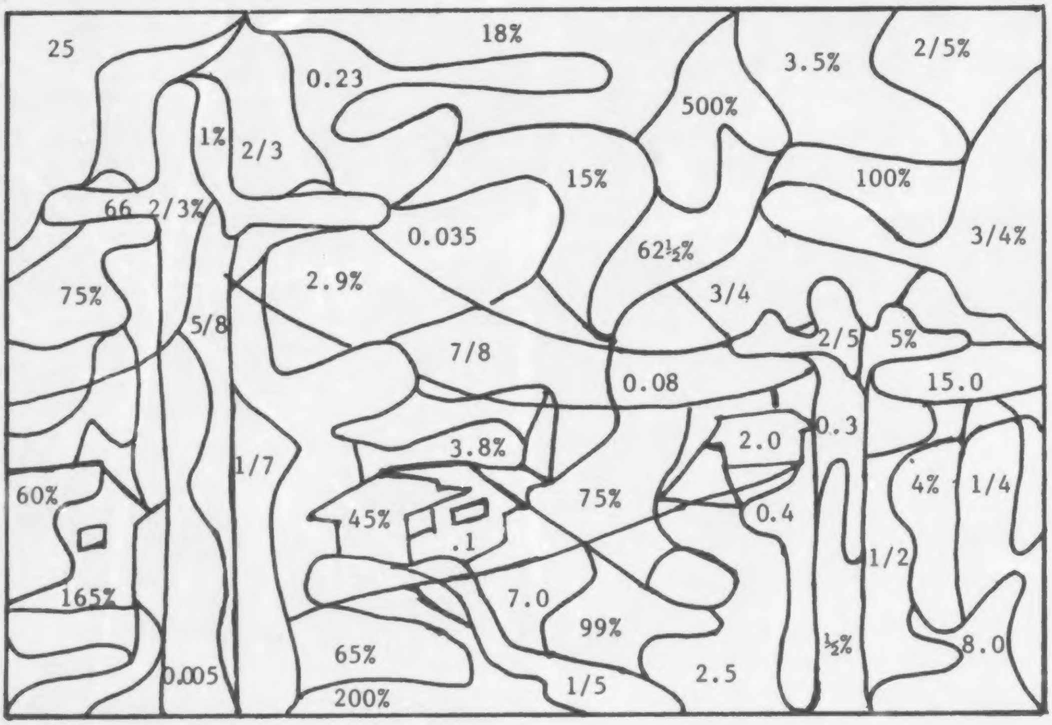
Theme 3. Energy Today — Sample Activity 3-2

Worksheet 3.2 — Grade Level 7-8

"Taking A Part?"

Directions:
1. Solve the 12 problems below.
2. Next, look for the puzzle piece that matches each answer and pencil in or color the entire puzzle piece.
3. After shading all 12 puzzle pieces, a picture concerning energy should appear.

1. 2/3 = %
2. 0.45 = %
3. Express ½% as a decimal.
4. Express 40% as a common fraction.
5. 1/20 = %
6. 1.65 = %
7. ½% x 20 =
8. 33 1/3% x 6 =
9. 2.5% x 12 =
10. 3/5 = %
11. Express 62½% as a common fraction.
12. 1/200 = %
13. 1/100 = %



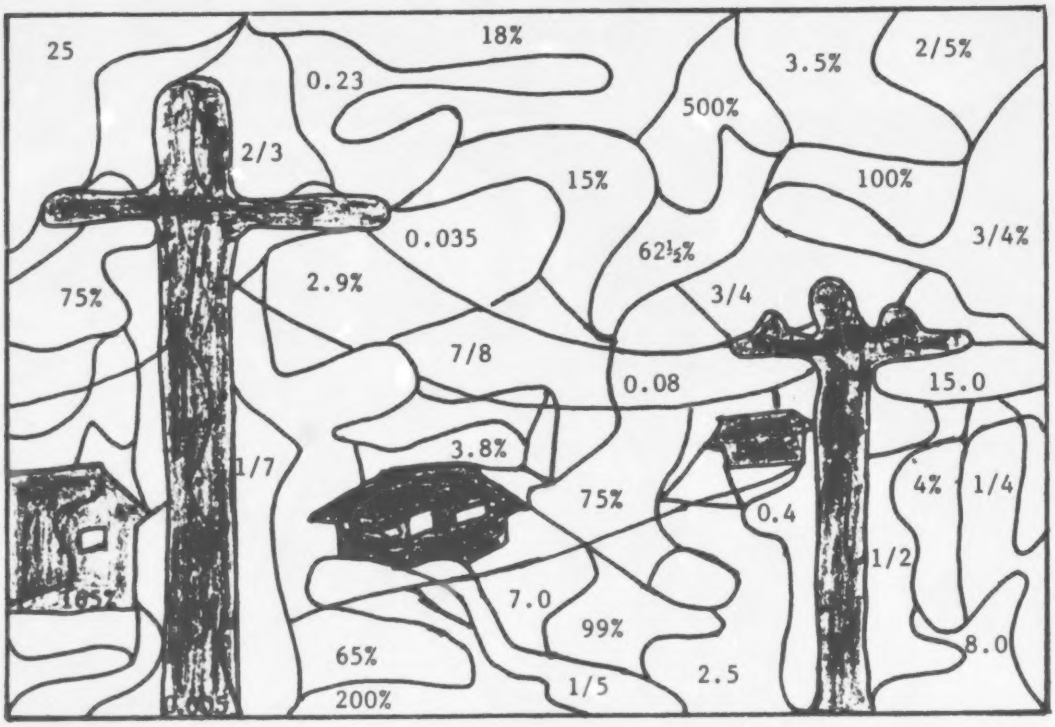
73

Theme 3. Energy Today | Sample Activity 3-2
Worksheet 3.2 - Teacher's Answer Sheet | Grade Level 7-8

"Taking A Part?"

Directions:
1. Solve the 12 problems below.
2. Next, look for the puzzle piece that matches each answer and pencil in or color the entire puzzle piece.
3. After shading all 12 puzzle pieces, a picture concerning energy should appear.

1. 2/3 = 66 2/3%
2. .45 = 45 %
3. Express ½% as a decimal. 0.005
4. Express 40% as a common fraction. 2/5
5. 1/20 = 5 %
6. 1.65 = 165 %
7. ½% x 20 = 0.1
8. 33 1/3% x 6 = 2
9. 2.5% x 12 = 0.3
10. 3/5 = 60 %
11. Express 62½% as a common fraction. 5/8
12. 1/200 = ½ %
13. 1/100 = 1 %



THEME 3. Energy Today

Subject Area Math (Bus, Sc, SS)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 3-3. "Energy Eaters"

OBJECTIVE

- To know current sources and uses of energy.

CONCEPTS

- The available energy sources fall into two basic categories: renewable and non-renewable.
- The major energy sources we use today are fossil fuels which are limited and non-renewable.
- The major users of energy are industrial, transportational, residential, and commercial.
- Hawaii imports almost all of its materials and energy sources from outside the State.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVRIONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 3. Energy Today

Sample Activity 3-3

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option X, Level A)

- Adds, subtracts, multiplies, and divides whole numbers, fractions, and decimals. (pg. 122)
- Solves simple equation in one unknown. (pg. 122)
- Estimates and rounds off as needed. (pg. 122)
- Understands and uses the relationship between common fractions and decimal fractions. (pg. 122)
- Organizes and analyzes data by constructing simple graphs or tables about familiar situations. (pg. 123)
- Reads and interprets charts, maps, and graphs. (pg. 123)
- Collects and classifies selected data, draws valid conclusions to make decisions. (pg. 123)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 3.3.
2. Worksheet 3.3.

Sample Activity 3-3

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 4, 5 & 10)

The energy consumption per person has climbed over the past years and has been compounded by a growing population. In Hawaii, a two percent annual population increase over the last forty (40) years combined with a 4 to 5 percent per capita yearly growth rate in energy consumption has produced a 9 to 10 percent annual growth rate in sales of electricity and "taxable fuels" (essentially fuels sold in the civilian market); these two categories represent an estimated 80 to 90 percent of all energy consumed in Hawaii over the last 30 years.

Ninety-two percent of the energy consumed in Hawaii, comes from petroleum. The transportation system (air, water, ground and military), consumes approximately 55% of the petroleum. Approximately 50% of the petroleum consumed by the transportation system (or 27% of the total petroleum energy used in the State), is used by the air transportation sector. Tourism accounts for the majority of the energy consumed by air transportation. The travel industry also affects ground transportation which accounts for approximately 15.6% of the petroleum energy used by the State or 28.4% of the petroleum used by the entire transportation sector.

The other 45% of the petroleum energy is consumed by the industrial-commercial sector (15%), the residential sector (13%), military sector (9%), not including transportation, and others (8%).

Based on available data, the State Energy Office estimates show that the average Hawaii resident in his/her home in his/her car uses about a fourth of all the energy in the state. On a per capita basis, the amount of energy consumed by local residents is much lower than in any other state.

In this activity, students will use basic math skills while learning about energy use in Hawaii.

1. Discuss the present energy situation with the students. Discuss Hawaii's energy situation. Point out to the students where we get our energy from, how we use the energy, and how much is used.

2. Discuss our major source of energy, petroleum, a fossil fuel. Introduce or review the terms renewable and non-renewable energy sources. In your discussion of petroleum, point out that when talking about barrels of crude oil, a barrel is not equivalent to 55 gallons but 42 gallons. (You may wish to show the students Figure 2 - "Average Annual Yields From a Barrel of Crude Oil," from Exercise 3.3.)

3. Distribute Exercise 3.3. (Note: The data in the exercise are factual.)

ACTIVITY (Cont'd.)

4. Discuss Exercise 3.3.
5. Distribute Worksheet 3.3 to have students learn more facts about energy today.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Challenge: Using the information from Exercise 3.3, make a circle graph representing the energy used by the various transportation sectors.

Theme 3. Energy Today — Sample Activity 3-3

Exercise 3.3 — Grade Level 9-12

"Energy Eaters"

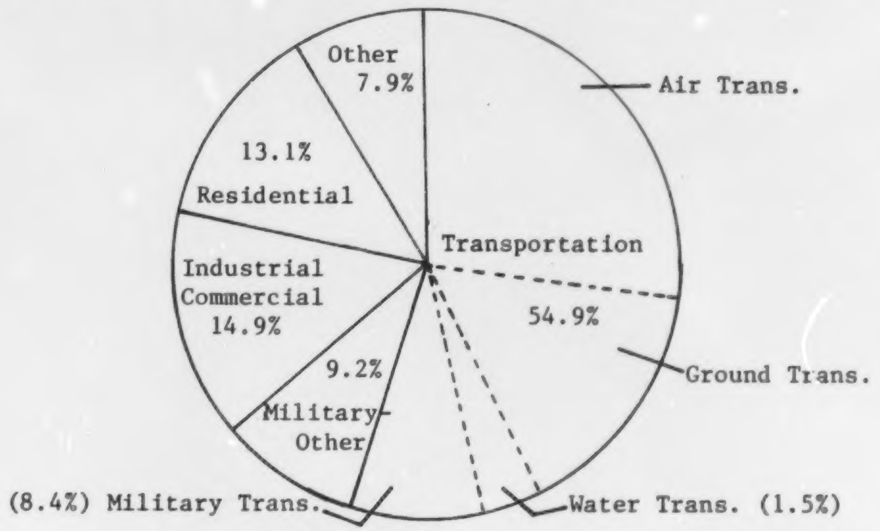
PART I: Petroleum Consumption

Directions: Solve the following problems. Use the data from Figure 1 in solving problems 1 - 5.

1. According to Figure 1, how many barrels of oil (petroleum) were used by Hawaii's residential sector?

2. How many barrels of oil were used by the industrial/commercial sector? (Express your answer to the nearest tenth of a million.)

Figure 1. Hawaii's Petroleum Consumption By Economic Sectors (1976)*



Source: State Energy Office Consultant unpublished report.
Barrels of oil = 39,624,192 (100%)

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*Taken from Energy Use In Hawaii, Department of Planning and Economic Development, State Energy Office, Honolulu, Hawaii, August 1978 (Revised), pg. 6.

Theme 3. Energy Today — Sample Activity 3-3

Exercise 3.3 (Cont'd.) — Grade Level 9-12

3. In 1976, it was estimated that 6,181,374 barrels of petroleum was used by ground transportation. What percent of the total petroleum consumption does this represent?

4. Based on the information from problem 3, what percent of the total petroleum consumption is due to air transportation?

5. If a barrel of petroleum contains 42 gallons, how many gallons of petroleum was consumed by the ground transportation sector in 1976?

PART II: Watt's In Crude Oil?

Directions: Use Figure 2 to solve problems 6 - 8.

Figure 2.
Average Annual Yields From A Barrel Of Crude Oil - 1976[*]

Product	Gallons per Barrel
Gasoline	19.11
Jet Fuel	2.86
Ethane (including ethylene)	0.04
Liquefied gases	1.01
Kerosene	0.46
Distillate fuel oil	9.16
Residual fuel oil	4.33
Petrochemical feedstocks	1.39
Special naphthas	0.29
Lubricants	0.54
Wax	0.04
Coke	1.09
Asphalt	1.18
Road oil	0.00
Still gas	1.55
Miscellaneous	0.42
Shortage[1]	-1.47
Totals	42.0

[*] Preliminary

[1] Processing gain (-) or loss (+)

Source: Percentage yield, U.S. Bureau of Mines; Gallons per barrel computed by American Petroleum Institute.

Theme 3. Energy Today — Sample Activity 3-3

Exercise 3.3 (Cont'd.) — Grade Level 9-12

6. If a barrel of crude oil contains 42 gallons, what is the percentage yield of gasoline from a barrel of crude oil? Yield of jet fuel? Yield of wax? Yield of lubricants?

7. In 1976, the average gasoline consumption was 574 gallons per vehicle. Based on the data in Figure 2, how many barrels of crude oil was necessary to supply 574 gallons of gasoline? If there were 536,514 motor vehicles registered in 1976, how many barrels of crude oil was used by island motorists?

8. Mrs. Hoopii uses 15.2 gallons of gasoline each week. If she decided to cut down her gasoline consumption by 10%, how many gallons would she use in a week? How many gallons in a month? A year? How many barrels of crude oil is equivalent to the gasoline saved by Mrs. Hoopii in a year?

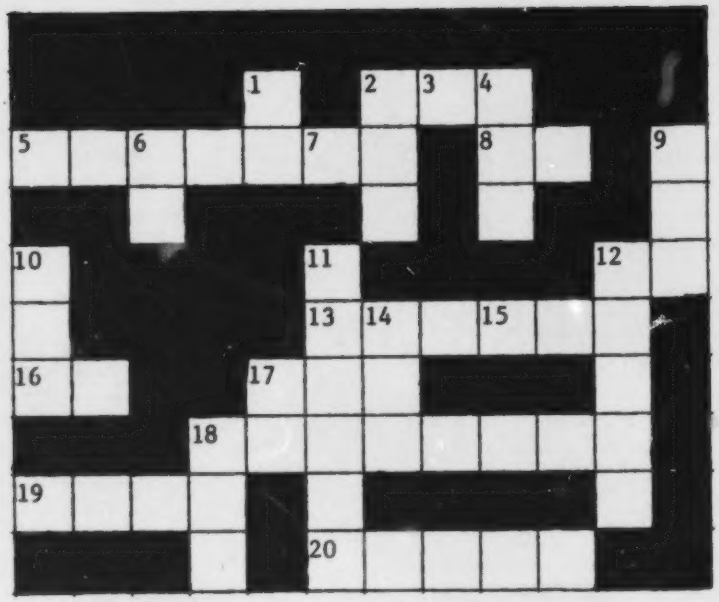
Theme 3. Energy Today

Worksheet 3.3

Sample Activity 3-3

Grade Level 9-12

"I've Got Your Number"



Across

1. A slide projector uses a 400 watt lamp. How much will it cost to operate the projector for 2½ hour if electricity costs 6¢ per kilowatt hour? Express your answer in cents. (Hint: To find kilowatt hour divide 400 watts by 1000 to find kilowatt, then multiply by 2½ hours.)

2. If a barrel of oil contains 42 gallons, how many gallons does 5 barrels contain?

5. In 1976, Hawaii used approximately 39,624,000 gallons of oil. The residential sector used 13.1% of that total. How many gallons of oil was consumed by the residential sector?

Down

1. A television set on a 110 volt line has a ampere of 0.61 amps. What is the power rating in watts for the television set. Express your answer to the nearest whole number. (Hint: watts = volts x amperes.)

2. About how far could a car that gets 13 mpg (miles per gallon) go on a barrel of crude oil? (See problem 8 across.)

3. Represents a unit.

4. If a car travels 300 kilometers and consumes 25 liters of gas, we say that the car has a fuel economy of ___ kilometers/liter

Theme 3. Energy Today

Worksheet 3.3 (Cont'd.)

Sample Activity 3-3

Grade Level 9-12

Across

8. The average yield of gasoline from a barrel of crude oil is 42¼%. How many gallons does that represent? (Express your answer to the nearest whole number.

12. Jean's car travels 440 miles before it needs a fill-up, the car require's 20 gallons. How many miles to a gallon does Jean's car deliver?

13. In 1976, 1,445,668 barrels of propane were consumed in Hawaii. The commercial and industrial sector of Hawaii used 47.0% of the total? How many barrels was that? (Express your answer to the nearest whole number.)

16. If a blow dryer has a wattage reading of 1500, how many minutes per week can you use the blow dryer if your mom allows the dryer to consume only 2.25 KWH each week?

17. Edna's pool pump uses 300 KWH of electricity each month. Edna's monthly KWH consumption is 2000. What percent of the KWH consumption is due to the pool pump?

18. In 1976, our total State consumption of electricity by residents was 5,615,000 KWH. In 1920, our consumption was only 0.31%. How many KWH of electricity did Hawaii residents consume in 1920?

19. If a barrel of gasoline contains 5,250,000 BTU's(British Thermal Unit) of heat energy, how many pounds of bagasse is needed to have a heat content equivalent to a barrel of gasoline? (Note: The heat content of bagasse is 4,100 BTU's/lb.) Express your answer to the nearest whole number.

Down

6. In 1976, the average island household of six consumed 2,000 KWH of electricity each month. If 4.8% was for lighting, how many KWH were consumed for lighting each month?

7. Same answer as 15 Down.

9. The average American car uses about a cup of fuel for every six minutes that it idles, how many quarts of fuel is used if the car is left to idle 48 minutes.

10. The odometer reading of Dean's car was 25,037.4; yesterday it was 24,897.4. How many miles did Dean travel since yesterday?

11. In 1976, there were 536,514 registered vehicles in Hawaii. If eighty-six percent of the vehicles were passenger cars, how many cars does that represent? (Express your answer to the nearest whole number.)

12. If the average consumption of electricity is 2,000 KWH per month for a family of 6, what is the annual consumption?

14. If a family of 2 uses 125 KWH of electricity each month for their 13 cubic foot refrigerator, how many KWH do they consume in ½ year?

15. How many KWH are consumed by a 4,000 watt self-cleaning oven in 1 hour?

17. A hair blower has a wattage reading of 1,200 watts. How many hours each month is it used if the monthly KWH consumption was 8.4?

Theme 3. Energy Today

Worksheet 3.3 (Cont'd.)

Sample Activity 3-3

Grade Level 9-12

Across

20. In 1976, Hawaii consumed 93,678 barrels of aviation gas, (This does not include gas used by foreign airlines.) Of this total 28.5% was consumed by the non-commercial sector. How many barrels of aviation gas does this represent? (Express your answer to the nearest whole number.)

Down

18. If one hundred 100-watt bulbs burn for 10 hours, how many kilowatt-hours of electricity would they consume?

Theme 3. Energy Today

Sample Activity 3-3

Worksheet 3.3 - Teacher's Answer Sheet

Grade Level 9-12

"I've Got Your Number"

■	■	■	■	^{1}6	■	^{2}2	^{3}1	^{4}0	■	■	■
^{5}5	1	^{6}9	0	7	^{7}4	4	■	^{8}1	9	■	^{9}0
■	■	6	■	■	■	7	■	2	■	■	0
^{10}1	■	■	■	■	^{11}4	■	■	■	■	^{12}2	2
3	■	■	■	■	^{13}6	^{14}7	9	^{15}4	6	4	■
^{16}9	0	■	■	^{17}0	1	5	■	■	■	0	■
■	■	■	^{18}1	7	4	0	6	5	0	0	■
^{19}1	2	8	0	■	0	■	■	■	■	0	■
■	■	■	0	■	^{20}2	6	6	9	8	■	■

THEME 3. Energy Today

Subject Area Math (Bus, Sc, SS)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 3-4. "There's No Fuel Like an Old Fuel"

OBJECTIVE

- To know current sources and uses of energy.

CONCEPTS

- The available energy sources fall into two basic categories: renewable and non-renewable.
- The major energy sources we use today are fossil fuels which are limited and non-renewable.
- The major uses of energy are industrial, transportational, residential, and commercial.
- The availability of energy sources affects and is affected by technology and by political, social, economic and cultural systems.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 14. Demonstrate knowledge of the citizen's opportunities to participate in political processes.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditonal sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will demonstrate their awareness of population processes and dynamics. (Goal: pg. D23)
- Students will examine optional courses of actions and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Sample Activity 3-4

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Core Algebra)

- Performs the four basic operations with simple rational expressions. (pg. 126)
- Translates algebraic statements into verbal statements and conversely. (pg. 126)
- Given a verbal problem, writes an appropriate equation, solves the equation, interprets the problem in terms of the problem setting. (pg. 127)
- Interprets a graph by stating what it shows and makes a table from it. (pg. 127)
- Applies formulas that arise from real-world situations. (pg. 128)

SUGGESTED MATERIALS AND/OR RESOURCES

Exercise 3.4.

87

Theme 3. Energy Today

Sample Activity 3-4

Grade Level 9-12

ACTIVITY (Related Core Themes: 2, 4, 5, 11 & 12)

Energy is an integral part of our life. We need energy to live, work, think, and play. The energy we once considered abundant and cheap is now expensive and slowly being depleted.

The growth of America was accompanied by our extravagant use of energy. By the 1970's, our demand for fossil fuel outstripped our own supply and we became dependent on foreign oil. The United States accounts for 1/6 of the world's population and is responsible for about 1/3 of the world's energy consumption.

Energy choices need to be made for the future. How are these choices to be made? Who should make these choices? Whatever the choices, our future life style will be greatly affected.

In this activity, students will learn about our present energy situation while learning graphing skills.

1. Discuss the present energy situation with the students. Point out that the fossil fuels we use are limited and non-renewable.
2. Discuss some of the users of energy such as industry, transportation, businesses, and consumers.
3. Discuss where Hawaii gets its energy. Students should be made to realize that Hawaii has no fossil fuel and therefore imports most of the needed energy from foreign soils.
4. Distribute Exercise 3.4, "There's No Fuel Like An Old Fuel."
5. After students have completed the exercise, ask them the following questions:
    a) How does OPEC affect the oil prices? Is the effect evident in Figure 1 of Exercise 3.4?
    b) How has the increasing oil prices affected your life?
    c) What conservation measures do you practice?
    d) Do you feel Americans are energy gluttons? Why or why not?
6. What is the relationship between energy consumption and population?

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Visit the public library and/or call the State Energy Office and obtain the latest information regarding (1) imported crude oil prices, (2) U.S. population and energy consumption, and (3) world population and energy consumption. Plot the latest information on your graphs from Exercise 3.4.

Theme 3. Energy Today

Exercise 3.4 - "There's No Fuel Like An Old Fuel"

Sample Activity 3-4

Grade Level 9-12

PART I: Oil Imports

Directions: Using the data in Figure 1, do the problems that follow.

Fig. 1 - U.S. Yearly Price for Imported Crude Oil[1]

Year	Average Cost Per Barrel[2]
1970	$ 1.80
1971	2.20
1972	2.50
1973	5.20
1974	11.25
1975	12.60
1976	13.05
1977	14.00
1978	13.90
1979	23.30

[1] Information from Department of Energy Information Service, Washington, D.C.

[2] Prices represent average prices of imported crude oil from various countries.

1. Graph the data from Figure 1. Plot the year on the "x" axis and cost per barrel on the "y" axis. Be sure to label your graph.

2. Look at the graph plotted. During which year(s) did the price of crude oil jump by approximately 100%?

3. Does the graph show a decline at any point? If so, what reasons could you give for the decline?

4. One source reported that the price of crude oil in 1979 was $25 a barrel. Why is there a discrepancy in their figure and the one given here? Did you think that in 1979 crude oil was also sold for less than $23.30 a barrel? Explain.

5. What was the price of a gallon of crude oil in 1970? In 1980? (Hint: There are 42 gallons of crude oil in each barrel.)

PART II: Population and Energy Consumption[1]

DIRECTIONS: Compute the following problems using the information provided in Figures 2 and 3.

FIGURE 2
Historical Record of U.S. Population Growth and Energy Consumption

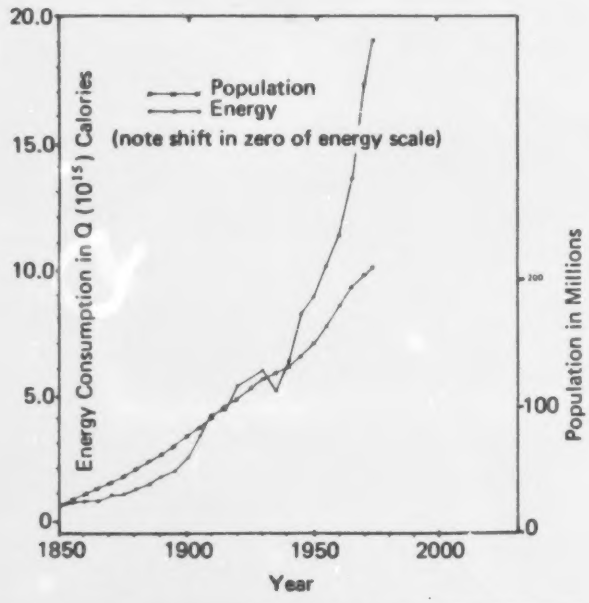
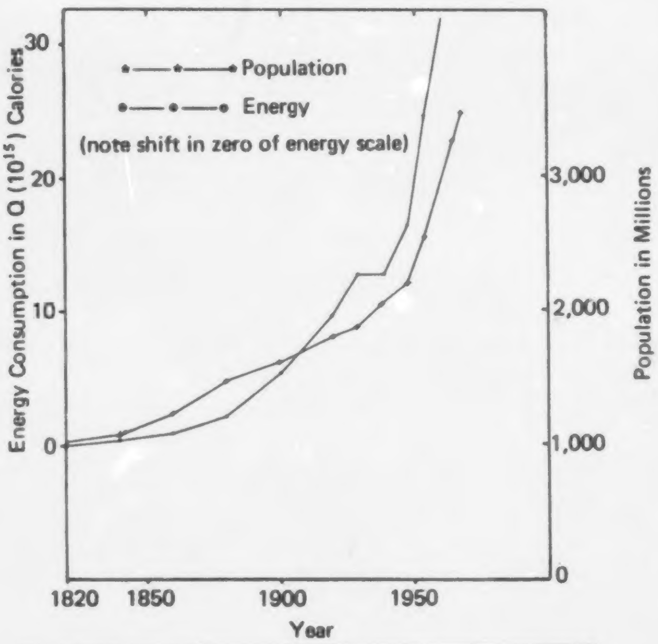


FIGURE 3
Historical Record of World Population Growth and Energy Consumption



1. What was the U.S. population in 1950? What was the world's population for that same year? What percent of the world's population resided in the U.S. in 1950?

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[1] Data from Energy-Environment Source Book by John M. Fowler. National Science Teachers Association, Washington, D.C., pg. 154.

Exercise 3.4 (Cont'd.)

2. How much energy was consumed by the U.S. in 1950? How much energy was consumed by the world in that same year? What percent of the world's energy consumption did the U.S. account for?

3. According to your data from problems 1 and 2, what generalization can you make regarding energy consumption of Americans versus the rest of the world?

4. Figures 2 and 3 show energy consumption steadily increasing. During what year was there a drop in energy consumption in the U.S.? In the world? What accounts for this decline?

5. Calculate the calories used per person in 1900 for an average American citizen and for the average citizen of the world. How many more calories per person does an average American citizen use as compared to an average world citizen? (Calculate answers to the nearest tenth.)

6. Calculate the calories used per person in 1950 for an average American citizen and the average world citizen. What is the percent increase of energy consumption from 1900 to 1950 for each? (Calculate answers to the nearest tenth.)

THEME 4. CONSERVATION

BACKGROUND

Theme 4 considers energy conservation practices as a way of helping to deal with the problem of increasing demands and decreasing supplies of energy resources. Energy is becoming scarcer and costlier as a result of fossil fuel supplies not meeting the present demands. This is a problem which touches the lives of all people.

As a result of energy conservation, the economic and environmental costs of energy may be reduced and time to research alternative energy sources may be increased. Energy conservation and the use of different energy alternatives may also reduce dependence on outside sources and increase the availability of scarce energy resources for use by developing nations and future generations.

Since the manner in which young people are oriented to energy use is an important determinant of the level of energy use within their society, it is of utmost importance that students are taught to value and practice a conservation ethic. Understanding this will help students in making everyday decisions to use energy more efficiently and with less waste. They should also be encouraged to formulate and follow their own plans of action to meet the energy, economic and environmental challenges presented by fossil-fuel shortages. Informed students who are willing and able to act responsibly can contribute to the solution of energy-related problems.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To formulate and practice a conservation ethic in regard to energy use and the environment.

Theme 4. Conservation

CONCEPTS

1. The earth's resources are limited.
2. Energy conservation is the wise and efficient use of energy.
3. Conservation of fossil fuels will allow more time to identify new energy sources and to develop appropriate energy conversion systems.
4. Energy conservation will affect and be affected by present and future life styles and cultural conditions.
5. Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of particular energy sources.
6. Energy conservation and the use of different energy alternatives in Hawaii will reduce dependency on imported energy sources and increase energy self-sufficiency.

93

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 59 - Unit VII) Agriculture is faced with environmental problems that are both internal and external.

ART: (pg. 7 - Objective) Communicate ideas, thoughts, and feelings through various modes of self-expression in a unique and creative way.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) A knowledge and understanding of the customs and mores of society reflected in the student's behavior when living among the foreign group.

BASIC PRACTICAL ARTS: (pg. 4 - Objectives) 1. To effectively utilize the resources of our technological world and to understand the importance of conservation. 2. To develop an awareness of the needs of society for goods and services and how goods and services are effectively provided.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HEALTH: (pg. iii & 1 - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experience contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Purchase consumer goods and services appropriate to an overall consumption plan and wise use of economic resources.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop ability to think critically and to solve problems.

MUSIC: (pg. 2 - Objective) Use musical skills in communicating ideas, thoughts and feelings.

PHYSICAL EDUCATION: (pg. 106 - Objective) Move skillfully and know the concepts relevant to all physical movement.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Foster the students' appreciation for the practical and aesthetic contribution of science to the improvement of quality of life and to promote in our students the desire to take an active part in that contribution. 2. Prepare the children for useful effective citizenship in and a curiosity about the future both for themselves and for the civilization of which they are a part. 3. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

SOCIAL STUDIES: (pg. 11 - Objectives) 1. The student is able to clarify value conflicts of communication problems which affect choices, decisions, or relationships. 2. The student is able to construct, evaluate, and revise alternatives for personal goals, plans, or problem solutions, considering costs and benefits to self and to others affected by his or her decisions.

THEME 4. Conservation

Subject Area Mathematics
Grade Level 7-12

THINGS TO DO

*1. Compare the energy efficiency of incandescent and fluourescent light bulbs. (See Sample Activity 4-1. "Lumens vs Lumens.")

*2. Find out the average KWH consumption for various size households. How many KWH of electricity can a family of 6 conserve if it reduces its use of television by 50%? (See Sample Activity 4-2. "Energy Ratios.")

*3. Investigate various types/sizes of cars and determine which one is the best buy. Consider such factors as base cost, insurance, maintenance costs, etc. (See Sample Activity 4-3. "A Logical Conclusion.")

*4. If you were given a limited amount of resources, how could you use the materials efficiently and wisely? What factors must you consider? (See Sample Activity 4-4. "More Means Less?")

*5. Many of the goods we buy use energy intensive packaging. How can we best design containers, etc. to make the best use of materials? (See Sample Activity 4-5. "The Limits of Energy.")

6. Weigh packaging (including containers) that could accumulate in a shopping day. Write a brief statement concerning the energy needed to create the total packaging pile. Suggest alternative packaging. How can we conserve energy by using alternate packaging?

7. Count the light bulbs in your home and list their wattage. Calculate the kilowatt-hours used by these light bulbs during several evenings by noting the time each light is turned on and when it is turned off. Calculate the average kilowatt-hours used per month and the cost. How can you reduce this amount?

VOCABULARY

Alternatives, conservation, consumption, efficient use, energy audit, energy intensive, fossil fuel, fuel economy, kilowatt, kilowatt-hour, lumens, mileage, overpackaging, recycle, responsible decision-making, speed, watt, wise-use.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

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* For detailed description, refer to noted Sample Activity.

Note to teacher: (Cont'd.)

a. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D. C., 1975.
b. Energy Use in Hawaii. Department of Planning and Economic Development, State Energy Office, State of Hawaii, November 1977.
c. Hawaii Home Energy Saver's Guide. Department of Planning and Economic Development, State Energy Office, State of Hawaii, 1980.
d. Materials and Energy from Municipal Waste. Resource Recovery and Recycling from Municipal Solid Waste and Beverage Container Deposit Legislation, Congress of United States, Washington, D. C., July 1979.
e. Conservation leaflets and pamphlets from the State Energy Office and Federal Energy Office.

96

THEME 4. Conservation

Subject Area Math (IA, IT, Sc)
Thematic Area EE, G, LS, SA, VE
Grade Level 7-8

SAMPLE ACTIVITY 4-1. "Lumens vs. Lumens"

OBJECTIVE

- Formulate and practice a conservation ethic in regard to energy use and the environment.

CONCEPTS

- Energy conservation is the wise and efficient use of energy.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs.

MATHEMATICS PROGRAM LEARNER OBJECTIVES

- Adds, subtracts, multiplies, and divides whole numbers. (pg. 96)
- Understands and uses the relationship between common fractions (simple and mixed) and decimal fractions. (pg. 97)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 4.1.
2. Worksheet 4.1.

Theme 4. Conservation

Sample Activity 4-1

Grade Level 7-8

ACTIVITY (Related Core Themes: 1, 5, 6, 7, & 10)

Background:

The wattage given a light bulb is not the amount of light given off but instead it is a measure of how much energy needed to operate a given product. The amount of light given off is measured in lumens. Bulb packages give not only the wattage, but also the lumens produced by a bulb.

1. Class discussion:
   a. Begin by asking students if they know the difference between incandescent and fluorescent lighting. Have students share what they know. Ask them if they notice a change in the lighting of streets in various parts of the city. Discuss what the lights are like and why the change. Ask them which type of lighting is more energy efficient by comparing several incandescent and fluorescent bulbs for efficiency. Have them do Exercise 4.1 for homework.

2. Follow-up discussion:
   a. Discuss the homework assignment with the students. (Optional: demonstrate using a radiometer that show fluorescent lights give off little heat (radiometer will hardly move; whereas incandescent light will give off more heat causing the radiometer to move). Discuss the advantages and disadvantages of the various degrees of heat given off by the two types of lights.

3. Distribute Worksheet 4.1 as a review exercise in basic math skills.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

1. Find out through library research the advantages and disadvantages of each type of light bulb.
2. Call up some hardware stores and compare the cost of fluorescent vs. incandescent light bulbs.

Theme 4. Conservation
Sample Activity 4-1
Exercise 4.1
Grade Level 7-8

"Lumens vs. Lumens"

Name ______________________________

Determine the efficiency of the following bulbs. First find out the lumens for each of the bulbs listed. After your findings answer the questions.

Example: A 100-watt incandescent bulb may yield 1750 lumens. What is the efficiency in lumens per watt?

Solution: Wattage = 100
Lumens = 1750

Therefore: $$\frac{1750 \text{ lumens}}{100 \text{ watts}} = 17.5\ \frac{\text{lumens}}{\text{per watt}}$$

I. Problems:

1. 100 watt fluorescent bulb: $\frac{\_\_\_\_ \text{ lumens}}{100 \text{ watts}} =$ ____ lumens per watt
2. 40 watt fluorescent bulb: $\frac{\_\_\_\_ \text{ lumens}}{40 \text{ watts}} =$ ____ lumens per watt
3. 100 watt incandescent bulb: $\frac{\_\_\_\_ \text{ lumens}}{100 \text{ watts}} =$ ____ lumens per watt
4. 25 watt incandescent bulb: $\frac{\_\_\_\_ \text{ lumens}}{25 \text{ watts}} =$ ____ lumens per watt
5. 250 watt incandescent bulb: $\frac{\_\_\_\_ \text{ lumens}}{250 \text{ watts}} =$ ____ lumens per watt

II. Questions:

1. Which type of lighting is more efficient--incandescent or fluorescent?
2. Is it more efficient to buy four 25-watt or one 100-watt incandescent bulb?
3. Does the incandescent light increase in efficiency as the wattage increases?
4. Do you think everyone should switch to fluorescent lighting? Why or why not?
5. Does your school use fluorescent or incandescent lighting? Survey your school and find out.

   Fluorescent _______ Incandescent ____

Theme 4. Conservation — Sample Activity 4-1

Worksheet 4.1 — Grade Level 7-8

"Color Me Lightly"

Directions:
1. Solve the 11 problems below.
2. Next, look for the puzzle piece on the next page that matches each answer and pencil in or color the entire puzzle piece.
3. After shading all 11 puzzle pieces, a picture concerning energy should appear.

1.
37
5143
218
+ 725

2.
19
[illegible]
[illegible]
+ [illegible]

3.
10952
- 887

4.
10540
- 9755

5.
202
x 15

6.
129
x 23

7.
29
x 22

8. $131\overline{)1703}$

9. $15\overline{)255}$

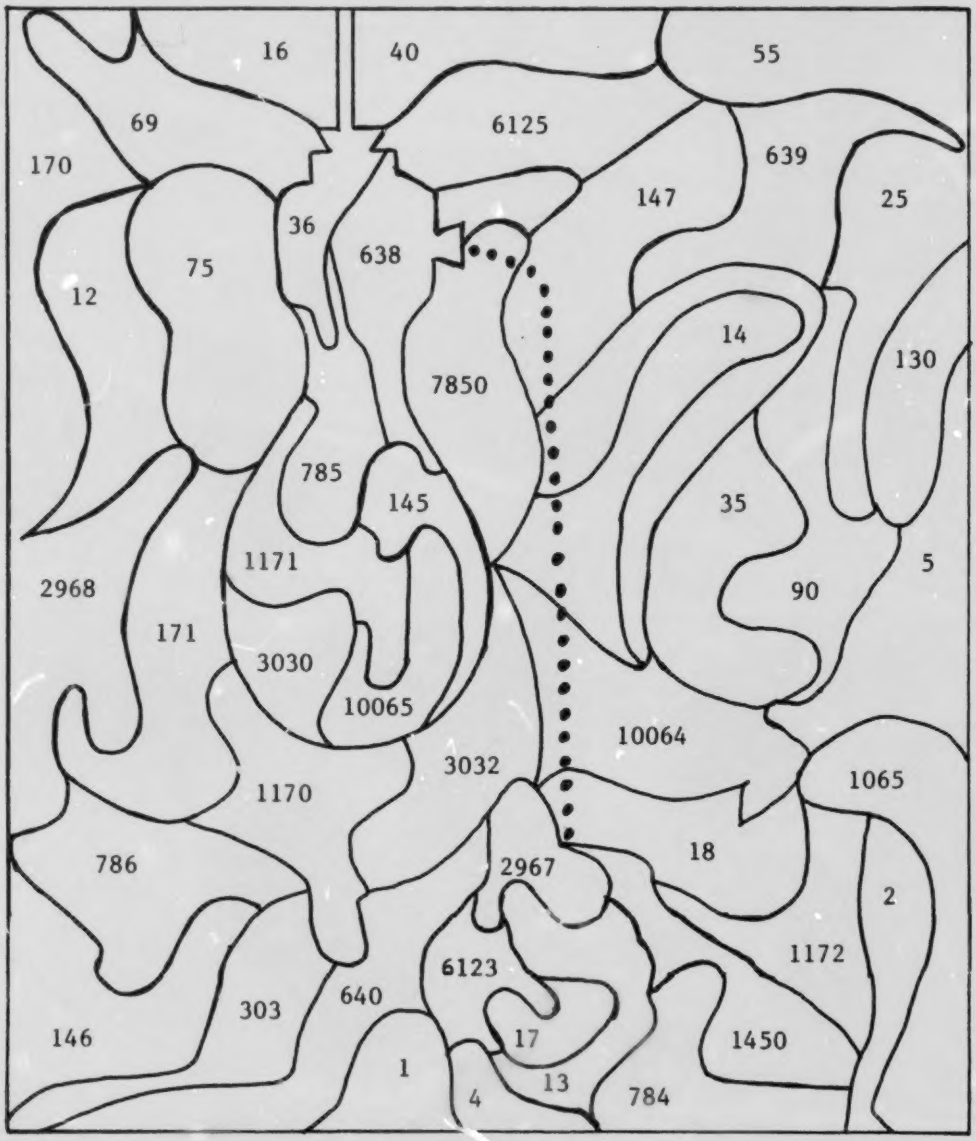
10. $3412\overline{)122832}$

11. $21\overline{)3045}$

Theme 4. Conservation Sample Activity 4-1

Worksheet 4.1 (Cont'd.) Grade Level 7-8

"Color Me Lightly"



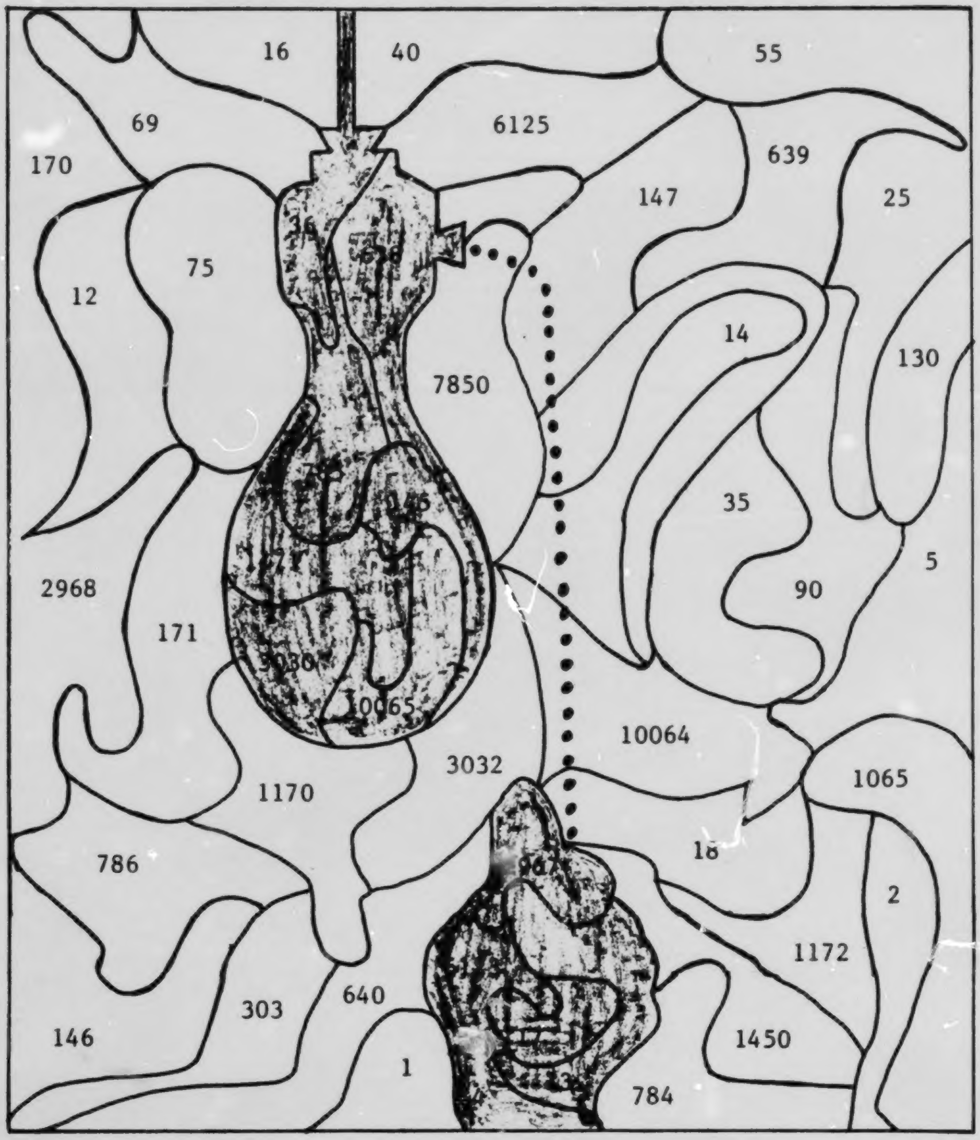
Sample Activity 4-1

Worksheet 4.1 (Cont'd.)

Grade Level 7-8

Teacher's Answer Sheet

"Color Me Lightly"



Answers:
1. 6,123
2. 1,171
3. 10,065
4. 785
5. 3,030
6. 2,967
7. 638
8. 13
9. 17
10. 36
11. 145
12. 4

102

THEME 4. Conservation

Subject Area Math (BPA, LA, Sc)
Thematic Area EE, G, LS, VE
Grade Level 7-8

SAMPLE ACTIVITY 4-2. "Energy Ratios"

OBJECTIVE

- To formulate and practice a conservation ethic in regard to energy use and the environment.

CONCEPTS

- The earth's resources are limited.
- Energy conservation is the wise and efficient use of energy.
- Energy conservation will affect and be affected by present and future lifestyles and cultural conditions.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)
- Students will demonstrate their awareness of population processes and dynamics. (Goal: pg. D23)

MATHEMATICS PROGRAM LEARNER OBJECTIVES

- Adds, subtracts, multiplies, and divides whole numbers. (pg. 96)
- Adds, subtracts, multiplies, and divides fractions and mixed numbers. (pg. 97)
- Understands and uses ratios and proportions. (pg. 98)
- Uses appropriate tools and units to measure objects. (pg. 100)

Theme 4. Conservation

Sample Activity 4-2

Grade Level 7-8

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 4.2.
2. Worksheet 4.2.
3. A scale to weigh the newspaper (a metric scale, if possible).

104

Theme 4. Conservation

Sample Activity 4-2

Grade Level 7-8

ACTIVITY (Related Core Themes: 1, 3, 5, 8 & 9)

Dwindling existing fossil fuel energy resources--coal, petroleum, natural gas--coupled with financial and environmental costs of developing new sources of energy make energy conservation essential. Conservation is the wise and efficient use of resource.

Personal use of energy in the United States accounts for 37% of the country's energy use. As individuals we can conserve energy in the areas of automobile travel and residential use of electricity and purchasing habits. For example, using a solar clothes dryer (the clothesline) instead of an electric dryer saves $30-$90 annually. Proper maintenance of an automobile can improve fuel economy by as much as 12%. It takes twice as much energy to produce a 6-ounce aerosol can of oil than that required for an equal amount of bottled cooking oil.

What is necessary is to bring our demand for energy in line with the supply. Energy conservation is one source of new energy at present and it will provide the time necessary for development of renewable sources and a new look at once used but forgotten sources.

In this activity, students will practice their skills in fractions while learning factual information regarding energy conservation.

1. Review addition, subtraction, multiplication, and division of fractions.
2. As an added review, have students do Worksheet 4.2.
3. After discussing Worksheet 4.2 have students do Exercise 4.2.
4. After students have completed the exercise, discuss the following questions:
    a) What is energy conservation?
    b) Is conservation the same as preservation?
    c) Give examples of how we can conserve energy.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Collect your daily newspaper for one week and bring them to class. At the end of the week, weigh your newspaper. Find out how much recycling plants are currently paying for newspaper. Calculate the amount of money your class could make each month if all of you recycled your paper. Take the newspapers to the recycling plant and decide as a class how to use the money.

Theme 4. Conservation
Exercise 4.2

Sample Activity 4-2
Grade Level 7-8

"A Part of the Action"

Directions: Using the data from Table 1, answer the following questions. Express fractions in simplest form.

1. What is the total annual KWH used by a family of 6? Family of 4? Family of 3? Family of 2?

2. How many KWH of electricity are used by a family of 4 in operating their water heater? A family of 4? Which one uses more? How much more? How many times as much? What fractional part of the total KWH usage is for the hot water for both families?

3. How many KWH of electricity are used by a family of 4 for cooking each month? What fractional part of the total KWH used is it?

4. How many KWH are used each month by a family of 2 in operating a clothes dryer?

5. Assume that the 2-member household mentioned in Problem 4 uses the clothesline instead of the clothes dryer on the average 1/4 of the year. How many KWH are conserved?

6. How many KWH of electricity are conserved if a family of 6 reduces the use of color television by 1/2? What would their new annual KWH be?

7. Calculate the fractional part of KWH used for lighting and refrigeration (include the freezer) for each of the 4 types of household.

Table 1. Hawaii Home Energy Cost Chart, 1980, Estimated 1980 Annual Energy Consumption[1]

	Number in Household			
	6	4	3	2
APPLIANCE	KWH	KWH	KWH	KWH
Water Heater	7200	4800	3600	2400
Refrigerator (Frost-Free)	3000	2400	1500	1500
Freezer (Frost-Free)	1800	1800	1800	1800
Cooking (Range)	1800	1200	900	600
Clothes Dryer	1440	960	720	480
Lighting	1200	960	780	600
Color TV (Solid State)	640	480	360	360
Dishwasher	480	360	300	240
Black & White TV (Solid State)	150	120	100	80
Miscellaneous Appliances	720	600	360	180

[1] From Hawaii Home Energy Saver's Guide, State Energy Office, Department of Planning and Economic Development, 1980.

Theme 4. Conservation

Sample Activity 4-2

Worksheet 4.2 - "A Ratio(nal) Idea"

Grade Level 7-8

Directions:
1. Do each of the 23 problems below.
2. In Table 1, find the letters that correspond to your answers.
3. Write the letters in the blanks that correspond to the problems.

Example: To discover the first letter of the first word of the message, solve problem 1 which reads 1/4 + 1/8. The answer is 3/8. From Table 1 you can see that 3/8 corresponds to letter "P". The letter in the first blank should therefore be "P".

TABLE 1.

A	B	C	D	E	F	G	H	I	J	K	L	M
2	6 1/2	5 1/7	3/4	5/8	4 1/3	1 1/5	22/25	5	1/3	1 1/2	1	8 2/3

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
5/6	1/4	3/8	2 5/6	1 3/10	3	9	9 2/3	15/16	17/20	7	3 5/9	22/27

1 2 3 4   5 6 7 8 9   10 11 12   13 14 15 16

17 18 19 20 21 22 23.

1. 1/4 + 1/8 =
2. 15/16 + 1/16 =
3. 2 2/9 - 4/18 =
4. 1/2 + 1/3 =
5. 1 11/12 + 1/12 =
6. 1 3/25 - 6/25 =
7. 1/4 + 3/8 =
8. 10/8 + 3/4 =
9. 3/16 x 4 =
10. 2/3 x 6 1/2 =
11. 1/2 ÷ 2 =
12. 2/5 ÷ 4/13 =
13. 1/3 ÷ 13 =
14. 2/3 x 14 1/2 =
15. 1/2 x 5/4 =
16. 1/16 ÷ 1/16 =
17. 1/8 x 5 =
18. 6/7 ÷ 1/6=
19. (2/3 - 1/6)1/2 =
20. (3/4 + 1/2)2/3 =
21. (1/2 + 1/3) x 3/10 =
22. (14 1/4 - 5/4) x 2/3 =
23. (1 - 4/9) ÷ 5/32 =

Theme 4. Conservation

Sample Activity 4-2

Worksheet 4.2 - "A Ratio(nal) Idea"

Grade Level 7-8

Teacher's Answer Sheet

Directions:
1. Do each of the 23 problems below.
2. In Table 1, find the letters that correspond to your answers.
3. Write the letters in the blanks that correspond to the problems.

Example: To discover the first letter of the first word of the message, solve problem 1 which reads 1/4 + 1/8. The answer is 3/8. From Table 1 you can see that 3/8 corresponds to letter "P". The letter in the first blank should therefore be "P".

TABLE 1.

A	B	C	D	E	F	G	H	I	J	K	L	M
2	6 1/2	5 1/7	3/4	5/8	4 1/3	1 1/5	22/25	5	1/3	1 1/2	1	8 2/3

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
5/6	1/4	3/8	2 5/6	1 3/10	3	9	9 2/3	15/16	17/20	7	3 5/9	22/27

P	L	A	N	A	H	E	A	D	F	O	R	F	U	E	L
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

E	C	O	N	O	M	Y	.
17	18	19	20	21	22	23	

1. 1/4 + 1/8 = 3/8
2. 15/16 + 1/16 = 1
3. 2 2/9 - 4/18 = 2
4. 1/2 + 1/3 = 5/6
5. 1 11/12 + 1/12 = 2
6. 1 3/25 - 6/25 = 22/25
7. 1/4 + 3/8 = 5/8
8. 10/8 + 3/4 = 2
9. 3/16 x 4 = 3/4
10. 2/3 x 6 1/2 = 4 1/3
11. 1/2 ÷ 2 = 1/4
12. 2/5 ÷ 4/13 = 1 3/10
13. 1/3 ÷ 1/13 = 4 1/3
14. 2/3 x 14 1/2 = 9 2/3
15. 1/2 x 5/4 = 5/8
16. 1/16 ÷ 1/16 = 1
17. 1/8 x 5 = 5/8
18. 6/7 ÷ 1/6 = 5 1/7
19. (2/3 - 1/6)1/2 = ¼
20. (3/4 + 1/2)2/3 = 5/6
21. (1/2 + 1/3) x 3/10 = ¼
22. (14 1/4 - 5/4) x 2/3 = 8 2/3
23. (1 - 4/9) ÷ 5/32 = 3 5/9

THEME 4. Conservation

Subject Area Math (Sc)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 4-3. "A Logical Conclusion"

OBJECTIVE

- To formulate and practice a conservation ethic in regard to energy use and the environment.

CONCEPTS

- Energy conservation is the wise and efficient use of energy.
- Energy conservation will affect and be affected by present and future life styles and cultural conditions.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Selected Algebra Topics/Logic)

- Applies the fundamental counting principle to many situations. (pg. 134)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 4.3.
2. Worksheet 4.3.

Sample Activity 4-3

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 3, 5, & 10)

Most people driving today learned to drive at a time when gasoline was relatively inexpensive and abundant. At that time, most people bought cars for their power and performance and good gas mileage was a secondary consideration at best. Recently with the shortage of usable energy becoming a reality, the world has become energy conscious.

The days of cheap energy are over and the price of gasoline is increasing each year, sometimes each month. Americans are now learning to select cars for their fuel economy and and beginning to relearn proper driving habits that will help conserve gasoline. For example, hot rod, spin out starts, and jerky acceleration can increase fuel consumption by 2 miles per gallon in city traffic. Idling more than 30 seconds not only wastes gas, but does harm to the engine. By improving driving techniques, the gas-conscious driver can achieve between 30 to 50 percent better mileage than the driver who has poor driving habits.

In this activity students will solve logic problems while learning about fuel economy.

1. Discuss and/or review with students the definition of energy conservation. Stress the point that conservation does not necessarily mean using less energy but using energy wisely and efficiently.
2. Discuss how automobiles, as one of the largest consumers of fossil fuel energy, can conserve energy. How can automobile drivers help to conserve energy?
3. Distribute Exercise 4.3 and have students work on the problems.
4. Discuss Exercise 4.3.
5. Have students work on Worksheet 4.3.
6. Discuss Worksheet 4.3.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

1. If all of the drivers in Exercise 4.3 were to drive at a speed of 50 miles/hour instead of at the speed they drove in the race, how many gallons of gasoline would they have conserved?
2. Compare several types of cars and decide which would be the best buy. (See Worksheet 4.3.)

Theme 4. Conservation

Sample Activity 4-3

Exercise 4.3

Grade Level 9-12

"A Logical Conclusion"

Five motorcycle drivers recently participated in a 50-mile race. Each driver had a helmet of a different color. The colors were red, blue, green, white and black. Each motorcycle also was of a different color. The colors of the motorcycles were red, blue, green, white and black. The motorcycles were also numbered from 1 to 5 not necessarily respectively to the colors just mentioned. From the clues below, find out how each driver finished in the race, the color of the motorcycle he/she was riding, and the number of his/her motorcycle. Refer to the driver by his/her helmet color. (Hint: Make a data table and organize the information given.

CLUES:

1. None of the drivers had a motorcycle that matched the color of their helmets. (i.e. A driver of a red motorcycle did not wear a red helmet.)
2. No motorcycle finished the race in a place that corresponds to its number. (i.e. Motorcycle #1 did not finish in 1st place, etc.)
3. Motorcycle #3 did not finish in the top three places.
4. The winner finished in 3/4 the time it took the last motorcycle.
5. The driver wearing the red helmet won the race.
6. Motorcycle #4 was black.
7. The blue motorcycle finished behind the red motorcycle.
8. The last motorcycle took 1 (one) hour to finish the race.
9. Motorcycle #5 finished in third place.
10. The driver of motorcycle #2 was a friend of the driver in white helmet and of the driver of the red motorcycle.
11. The blue motorcycle took 55 minutes to complete the race.
12. The driver of the blue motorcycle wore a white helmet.
13. The driver wearing the green helmet finished ahead of the blue, red and black motorcycles.
14. The black motorcycle finished last.
15. Two of the motorcycles had times of 50 and 54 minutes.
16. Motorcycle #2 was neither blue nor black.
17. Motorcycle #3 was behind the red motorcycle on the first lap.
18. The woman driving car #1 finished in the top 3.
19. The driver of the motorcycle that placed last wanted to wear the green helmet.
20. A woman driver rode the white motorcycle.

Theme 4. Conservation Sample Activity 4-3

Exercise 4.3 - Teacher's Answer Sheet Grade Level 9-12

"A Logical Conclusion"

Motorcycle Number	Motorcycle Color	Helmet Color	Placed in Race
1	white	green	2nd
2	green	red	1st
3	blue	white	4th
4	black	blue	5th
5	red	black	3rd

Theme 4. Conservation

Sample Activity 4-3

Exercise 4.3 (Cont'd.)

Grade Level 9-12

Questions To Answer

Based on your solution to the motorcycle problem on the preceeding page, answer the following questions.

1. What was the speed (distance/time) for the green motorcycle? The blue motorcycle?

2. If the driver in the black helmet increased his/her speed by 10 miles per hour, how long would it take him/her to finish the race? (Assume that the driver begins and ends the race with a 10 mile/hour increase.)

3. If the other drivers continued at their original speeds, in what place would the driver in Question #2 now finish?

4. What are the rates of travel (speed) for the black motorcycle and the white motorcycle?

5. If the driver of the black motorcycle had a fuel economy of 50 miles per gallon, at 50 miles a hour, how many gallons of gasoline would he/she consume to finish the race?

6. If it is true that fuel economy is decreased by one mpg (mile per gallon) for each five mph (miles per hour) over 50, how many gallons of gasoline would be consumed by the white motorcycle if it has a fuel economy of 50 miles per gallon at speeds of 50 miles per hour?

Theme 4. Conservation

Worksheet 4.3

Sample Activity 4-3

Grade Level 9-12

"What's In A Car?"

Directions: Below are some factors to consider when purchasing a car. Interview the appropriate people and fill in the necessary information.

Factors	Subcompact	Compact	Full Size	Van	Luxury Car
Base cost					
Fina[illegible] charge					
Monthly payment					
Insurance*					
Fuel**					
Oil change					
Tune up					
Parts availability					
Tires					
Warranty					
Options***					
Passenger load					

*Base insurance on highest liability available, collision, comprehensive, uninsured motorist, and $100 deductible.

**Use EPA estimated mileage, 10,000 miles, and the current price of gasoline.

***Itemize the cost of the options you would include on a new vehicle and list them on another sheet.

QUESTION TO CONSIDER:

Based on your needs and on the data you collected, which of the cars above is the best buy? Write a short essay defending your selection.

THEME 4. Conservation

Subject Area Math (Art, HEc, Sc)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 4-4. "Less Means More?"

OBJECTIVE

- To formulate and practice a conservation ethic in regard to energy use and the environment.

CONCEPTS

- The earth's resources are limited.
- Energy conservation is the wise and efficient use of energy.
- Energy conservation will affect and be affected by present and future life styles and cultural conditions.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Z, Geometry B)

- Uses formulas to find areas and perimeters of polygonal regions. (pg. 142)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 4.4.
2. Worksheet 4.4.

Sample Activity 4-4

Grade Level 9-12

ACTIVITY (Related Core Themes: 3, 5, & 10)

Energy is used in the production of goods that we consider necessary and other goods that are considered to be luxuries. With energy sources dwindling and the price of goods increasing each year, it may be necessary to reevaluate some of our wants. The end result may entail energy conservation measures that will facilitate the reduction of imported oil and reduce our dependence on outside energy sources.

One way to conserve our energy resources is to use/or buy goods that are energy efficient and to buy and use materials and goods to meet the needs and purposes of their use. For example, purchasing the right equipment for your home and needs, using it wisely, and taking good care of it can reduce energy costs considerably. More durable products save the energy that would be required to make replacements more often. As the citizenry become better informed, they will be able to make wise and more responsible decisions in the marketplace.

In this activity students will use principles involving geometry to solve a problem concerning the use of a material resource.

1. Discuss and/or review the definition of energy conservation with the students. Point out that energy conservation does not necessarily mean using less energy but using available energy more efficiently and wisely.
2. Discuss ways in which students practice energy conservation at home or at school.
3. Distribute Exercise 4.4.
4. Discuss Exercise 4.4.
5. Distribute Worksheet 4.4.
6. Discuss Worksheet 4.4.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Working in groups, make a design using all three types of polygons as described in Exercise 4.4. The object is to cover the same kitchen floor described in Exercise 4.4 using a design that is aesthetically pleasing as well as economical.

Theme 4. Conservation

Sample Activity 4-4

Exercise 4.4

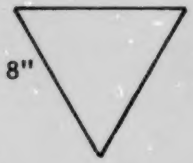
Grade Level 9-12

"More Means Less?"

Nani's kitchen floor measures 6 feet x 10 feet. Nani wants to retile her kitchen floor and has narrowed her choices down to 3 different shapes of tiles. The problem that Nani faces is to use as little tile as possible in getting the job done.

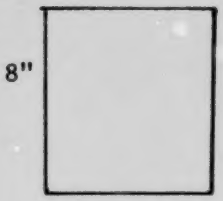
Below are pictures of the three (3) tiles and their dimensions.

Tile A:



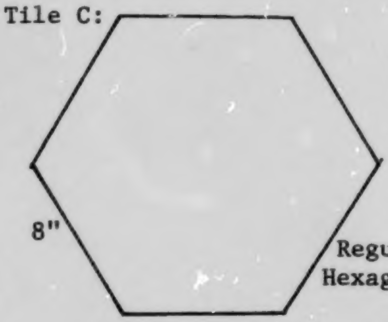
Equilateral Triangle

Tile B:



Square

Tile C:



Regular Hexagon

Problems:

1. How many triangular tiles would she need to resurface her kitchen floor? (Nani is allowed to cut the tiles, but she still has to count each tile as one tile.)

2. How many square tiles would she need to resurface her kitchen floor?

3. How many regular hexagon-shaped tiles would she need to resurface her kitchen floor?

4. Which tile shape would she use less of to resurface her kitchen floor?

5. If the cost of each tile is "x" dollars per square foot, what would be the cost of each tile?

6. Using the information from Problems 1-5, which geometric-shaped tile described in this exercise would be the cheapest to resurface Nani's kitchen floor?

7. If energy costs are considered and each cut in a tile amounts to "½x" dollars, what would be the energy cost for each tile? (Assume that each side of the tile figures require one cut and therefore a triangular shaped tile entails 3 cuts.)

8. Assume that each time Nani uses part of a tile, "¼x" dollars of energy is used for each cut. Using the information from Problems 1-7, which one of the three tile shapes described would incur the least energy costs to resurface Nani's floor?

Theme 4. Conservation Sample Activity 4-4

Worksheet 4.4 Grade Level 9-12

"Every Little Bit Counts"

PROBLEM: Your community association has made a deal with the people of your neighborhood. If they clean up the vacant lot next to a big brick building, they will receive 200 square yards of land to use as a park. Before they can have the land, they must enclose the land with a fence. The fencing must be shaped into three sides using the brick wall of the building as the fourth side to form a rectangle. The people in the community want to fence the area but conserve energy and save money as well. They wish to use as little fencing material as possible to enclose the 200 square yards.

QUESTIONS:

1. Would it make a difference how they shape the fence?
2. How can you check your answer for question #1?
3. What should the dimensions of the rectangular part be?
4. Examine your dimensions, is there a relationship between them? If so, what is the relationship?
5. If there was a relationship, do you think the relationship would work for 800 square meters as well? Show proof for your answer.
6. Do you think you would get the same relationship for any given area?

THEME 4. Conservation

Subject Area Math (Sc)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 4-5. "The Limits of Energy"

OBJECTIVE

- To formulate and practice a conservation ethic in regard to energy use and the environment.

CONCEPTS

- The earth's resources are limited.
- Energy conservation is the wise and efficient use of energy.
- Energy conservation will affect and be affected by present and future life styles and cultural conditions.
- Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of particular energy sources.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situation common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Z, Calculus)

- Applies differentiation to solving problems. (pg. 156)

Theme 4. Conservation

Sample Activity 4-5

Grade Level 9-12

SUGGESTED MATERIALS AND/OR RESOURCES

1. Transparency 4.5.
2. Exercise 4.5.

120

Theme 4. Conservation

Sample Activity 4-5

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 3, & 14)

We depend on natural resources to do and make things. Technology has enabled us to find resources and combine them in various ways to make things like cars, paper, beverage containers, convenience food, packaging, etc. However, our society has become a "disposable" society. What we have done over the ages is to convert a useable resource into a "waste," throw-away item. For example, mineral resources are mined, go to a refinery, are made into consumer goods, later to be used, discarded, and hauled away to a dump where they contribute to environmental degradation.

In 1976, Hawaii's solid waste totaled 1,058,500 tons. Many of the items found in the solid waste were packaging containers. The use of specialized containers consume enormous amounts of energy. For example a steel can (16 oz. steel top) consumes 3,993 BTU's per container, a 1-quart polyethylene bottle uses 9,897 BTU's, and an aluminum TV dinner container uses 5,938 BTU's per container. Throwing away one beverage bottle wastes as much energy as a 100 watt bulb uses in four hours.

In this activity students will study the problems of using resources efficiently.

1. Discuss and/or review the definition of energy conservation with the students. Students should understand that energy conservation does not necessarily mean using less energy but using what we have efficiently and wisely.
2. Show students Transparency 4.5 and discuss the energy needed in the production of containers.
3. Next, have students do Exercise 4.5.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Many of the quart oil containers are now being made out of cardboard. Investigate the energy cost/benefits of using cardboard instead of metals. What are some of the environmental cost/benefits of using cardboard? Of using metals?

Theme 4. Conservation
Transparency 4.5

Sample Activity 4-5
Grade Level 9-12

Energy Required to Produce Various Containers

Container	BTU/Container
Appliance box, corrugated (12"X12"X8")	10,648
Folding box, large (0.32 lb.)	6,553
Set-up box, small	2,867
Sanitary container (½ gal.)	3,003
Molded pulp tray (size 6)	1,526
Stave baskets	5,426
Hampers	5,563
Wooden berry basket	273
Steel can (16 oz. steel top	3,993
Aluminum can (12 oz. pop top)	6,518
Aluminum TV dinner container	5,938
Styrofoam tray (size 6)	853
Polyethylene bottle (1 qt.)	9,897
Polypropylene bottle (1 qt.)	10,921
Polyvinylchloride bottle (1 qt.)	13,310
Polyachrylonitrile bottle	3,345
Coca Cola bottle, returnable (16 oz.)	9,726
Coca Cola bottle, nonreturnable (16 oz.)	5,836
Glass milk bottle, returnable (½ gal.)	17,678
Glass vegetable jar (16 oz.)	4,061

It takes 1 gallon of gasoline to produce 138,000 BTU's

Theme 4. Conservation Sample Activity 4-5

Exercise 4.5 Grade Level 10-12

"The Limits of Energy"

1. On a small farm owned by Mr. Smith, the total production cost of "x" acres of feed grain is $\$(10x^2 + 350x + 25)$ and the gross income per acre is $\$(2000-x)$. What should the yearly output be in order to obtain a maximum total profit? What is the maximum profit?

2. Mr. Kono buys all of the feed grain from Mr. Smith. Each acre produces 75 bushels of feed grain (75 bushels measures approximately 225 cubic feet). Mr. Kono needs to build a cylindrical storage bin with an open top just large enough to hold the feed grain that he purchases from Mr. Smith. What are the dimensions which minimize the amount of material used to construct the bin?

3. An oil can is to be made in the form of a right cylinder to contain one quart of oil. What dimensions of the can will require the least amount of material? (1 quart = 1002.6 cm^3 or 57.75 in^3)

4. Based on the data below, which metal would be the cheapest to use for the oil can? Which would be the most expensive?

Table X: Energy and Cost Data of Various Metals.

Metals	Density g/cm^3	Selling Price per Kg.	Energy Expended in Calories per tonne
Steel	7.7	\$.24	7.2×10^6
Aluminum	2.7	.76	20.8×10^6 $(41.8 \times 10^6)^c$
Lead	11.34	.51	8.7×10^6
Copper	8.92	1.71	11.1×10^6
Zinc	7.14	.80	$12.8\text{-}14.4 \times 10^6$

a. Costs based on 1974 prices.
b. Tonne (1) is metric ton equivalent to 1000 kg or 1.1 tons.
c. The figure in parentheses includes the electric conversion losses.

5. If the thickness of the metal used is 2mm and the diameter of the can is 14cm, what would be the cheapest metal to use in terms of energy costs?

THEME 5. HUMAN DIMENSIONS OF ENERGY

BACKGROUND

This theme focuses on the importance of each individual's understanding of the relationships between personal choices of energy use and the quality of life for all. It explores the interrelationships among the concepts of standard of living, lifestyles, personal and cultural value systems, and social responsibility in the context of the "net" cost of energy production and use.

Demands of lifestyles resulting from technological achievements have produced an enormous increase in the demand for energy resources. The dependence on limited and/or costly supplies of energy to satisfy the needs and wants of humans has resulted in a problem that affects the lives of all people.

As individuals, we daily affect and are affected by the problems associated with energy use and our environment. To help solve these problems, we can find many ways to make better and more efficient use of energy without serious consequences to the environment or economy. In many instances, new attitudes and altered lifestyles will be necessary to conserve energy and eliminate the waste of resources. Individual efforts, when taken collectively, can result in substantial conservation of energy and other scarce resources. These efforts can also influence public policy making and/or governmental regulations in the areas of energy, environment, and economics.

Understanding of this theme will help students to formulate personal values which enable them to make competent energy choices and act responsibly to meet the challenges presented by energy shortages, threats to the environment and related economic problems. It will also help them realize personal commitments to responsibilities and cooperative actions for mutual benefit in terms of energy use and the environment.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 5. Develop physical, social and emotional health.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To understand that personal values and choices of energy use will affect the quality of life for all.

Theme 5. Human Dimensions of Energy

CONCEPTS

1. Energy-use decisions affect standards of living.
2. Individual and social values affect patterns of energy consumption.
3. Values and attitudes toward energy use and the environment are influenced by cultural, economic, political and social factors.
4. There are ethical, legal, aesthetic, social, political, economic, biological and physical benefits and costs associated with energy choices.

Theme 5. Human Dimensions of Energy

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 59 - Unit VII) Agriculture is faced with environmental problems that are both internal and external.

ART: (pg. 7 - Objective) Make and justify judgments about works of art and the selection of art products used in daily living.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 5 - Goal) To understand, through the second language, the contemporary values and behavior patterns of the people whose language is being learned.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objectives) 1. To live effectively in today's economic environment. 2. To meet the ever changing demand of the business world of work.

HEALTH: (pg. iii & 1 - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experiences contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Make and carry out intelligent decisions regarding the use of personal, family, and community resources.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Nurture intellectual curiosity and promote the desire to continue learning.

MUSIC: (pg. 2 - Objective) Use musical skills in communicating ideas, thoughts and feelings.

PHYSICAL EDUCATION: (pg. 106 - Objective) Acquire the habit of participating in wholesome recreational activities.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Foster the students' appreciation for the practical and aesthetic contribution of science to the improvement of quality of life and to promote in our students the desire to take an active part in that contribution. 2. Facilitate the students' ability to use scientific knowledge, processes, instruments and scientific language to clarify values, examine issues, solve problems in fulfilling personal, social and career life roles. 3. Encourage students to maintain a safe and healthy environment.

SOCIAL STUDIES: (pg. 11 - Objective) The students is able to clarify value conflicts or communication problems which affect choices, decisions, or relationships.

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

*1. A well-informed citizenry can make competent energy choices. Find out the various ways energy can be conserved at home and at school. (See Sample Activity 5-1. "Power to the People.")

2. Organize a student committee to work with school administrators to find ways of saving energy within the school. Outline your plan and point out the possible dollars and energy saved.

3. Estimate the minimum amount of energy that you would need for bare existence and give details to support your estimate.

4. Determine and compare the amount of fuel used in your community by the school buses, police cars, postal cars, etc. How many students in your school ride the bus to school? How many come to school in private automobiles? How many car pool?

5. Take an inventory of your neighborhood to determine the percentage of homes using gas and/or electricity for water heating, cooking, and other appliances. Record your findings on a bar graph. Find out if gas or electricity users conserve more energy. Is it easier to conserve energy if one fuel source is used instead of two? Why do people prefer gas over electricity?

VOCABULARY

Alternatives, change, choice, cooperation, energy cost, lifestyle, motive, needs, quality of life, recycle, reuse, scarcity, standard of living, supply and demand, value, wants.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Energy in Solid Waste. Citizens' Advisory Committee on Environmental Quality, Washington, D.C., 1975.
b. How to Save Money by Saving Energy. U. S. Department of Energy, Washington, D.C., November 1978.
c. Pamphlets and leaflets by the State Energy Office and Federal Energy Office.

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* For detailed description, refer to noted Sample Activity.

THEME 5. Human Dimensions of Energy

Subject Area Math (HEc, Sc, SS)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 5-1. "Power to the People"

OBJECTIVE

- To understand that personal values and choices of energy use will affect the quality of life for all.

CONCEPTS

- Energy use decisions affect standards of living.
- Individual and social values affect patterns of energy consumption.
- Values and attitudes toward energy use and the environment are influenced by cultural, economic, political and social factors.
- There are ethical, legal, aesthetic, social, political, economic, biological and physical benefits and costs associated with energy choices.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 2. Complete commonly used forms.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent thinking.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 5. Human Dimensions of Energy

Sample Activity 5-1

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Core Algebra)

- Performs the four basic operations with simple rational expressions. (pg. 126)
- Translates algebraic statements into verbal statements and conversely. (pg. 126)
- For a real-world situation, prepares and uses a table to discover a relationship or to decide the best course of action. (pg. 127)
- Given a verbal problem, writes an appropriate equation, solves the equation, interprets the problem in terms of the problem setting. (pg. 127)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 5.1.
2. Worksheet 5.1.

Theme 5. Human Dimensions of Energy

Sample Activity 5-1
Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 3, 4, 6, 9, 10 & 14)

Over the years, energy demand has been growing much faster than domestic supply. Our increasing dependence on foreign oil coupled with the formation of OPEC and the possibility of future oil embargoes, necessitates that demand for energy be restrained through conservation efforts. Attaining this objective requires the active support and cooperation of a well-informed citizenry.

An informed citizenry can conserve energy not only in the home or on the road but in the marketplace as well. For example, buying more durable products can conserve the energy that would be used to make replacements more often. Products made of recycled materials or those that can be recycled require less than 10% of the energy that would be needed for the same product made from the ore.

A well-informed citizenry will be able to make competent energy choices and act responsibly to meet the challenges presented by energy shortages, threats to the environment, and related economic problems.

In this activity, students will learn about conservation measures while practicing some algebraic skills in problem solving.

1. Discuss and/or review the definition of energy conservation as the wise and efficient use of energy.
2. Discuss ways in which students and/or their families have conserved energy.
3. Distribute Exercise 5.1.
4. Discuss Exercise 5.1.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

1. Telephone your recycling center to find out what household trash they will recycle and how they should be prepared for the center. Organize a school recycling project. Form a committee and appoint various people to different jobs such as recording the amount of cans and papers collected from each homeroom; recording the money value of recycled materials for each homeroom, etc.
2. Collect and separate your household trash. How much trash do you throw away a week. (See Worksheet 5.1.)

Theme 5. Human Dimensions of Energy　　Sample Activity 5-1

Exercise 5.1　　Grade Level 9-12

"Power to the People"

Directions: Do the problems below. Express all answers in fractions unless indicated otherwise.

1. Count the number of fluorescent bulbs in your classroom. If each fluorescent bulb is 40 watts, how many watts are there per fixture? How many watts are there in all the fixtures in your classroom? If the classroom lights were on for 1/4 day, how many kilowatt hours are used by your classroom? (The number of kilowatt hours is arrived at by multiplying the number of watts by the number of hours used, and dividing by 1000.) If 1/3 of the lights in your classroom were turned off, how many kilowatt hours would you conserve in a day? In 1/2 a year?

2. Mr. Oki travels from Kaneohe to Manoa, a distance of 22 2/5 kilometers, in a car that averages 9 3/10 kilometers per liter. Mr. Kumai travels from Manoa to Laie, a distance of 52 4/5 kilometers, in a car that averages 6 3/10 kilometers per liter. How many liters are required by Mr. Oki to make a round trip? How many liters are required by Mr. Kumai to make his round trip? If the price of gasoline is 36 6/10¢ per liter, how much does it cost each man to make his trip? Which man's car has the best fuel economy? Show proof for your answer.

3. A styling hair dryer has a power rating of 330 watts. How many kilowatts is this? (Express your answer as a fraction.) If the hair dryer is on for an average of 4 hours per month, how many kilowatt hours are used monthly? If the cost of electricity is 6 4/10¢ per kilowatt hour, what is the monthly cost of operating the hair dryer? If the use of the hair dryer was cut down by 1/3 each month, how much money could be saved?

4. Correct tire inflation can save a driver up to 190 2/5 liters per year. If gasoline costs $0.37 per liter, how much money would this save?

5. Old newspapers and other scrap papers can be recycled. Recycling centers are now paying 2¢ per pound. If one pound is equivalent to 9/20 kilogram, what is the price per kilogram? If an average family in Hawaii accumulates 2 2/5 kilograms of newspaper each week, how much money can they make in one month if they take their paper to the recycling center? In one year? If a family subscribes to both newspapers, how much will they make in one year if they recycle the paper? (Assume that the morning and evening papers weigh about the same and that the Sunday paper weighs 3/4 kilogram.) It has been estimated that one metric ton of recycled paper will save 16 trees. If this is so, how many trees per year could be saved by an average family which subscribes to both morning and evening papers?

6. List at least 3 energy conservation measures described in this exercise.

"Recycling Trash"

Directions: For one week collect and separate the household trash as listed below. Weigh each item and record the weight in the spaces provided. (If a scale in unavailable, devise a way to find the relative weights for each item.) At the end of the week determine the total weight of each item.

ITEM	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	WEEK'S TOTAL
Scrap food								
Plastic items								
Newspaper								
Waste paper (other than newspaper)								
Glass								
Metal (Aluminum)								
Metals (other than aluminum)								
Others								
WEIGHT OF TOTAL TRASH FOR ONE WEEK								

Problems:

1. Calculate the percent of the week's total trash each item represents.

132

Theme 5. Human Dimensions of Energy   Sample Activity 5-1
Worksheet 5.1 (Cont'd.)   Grade Level 9-12

2. Compare the average American trash components, as listed below, with yours. Is there a difference? Can you explain why?

Annual Household Solid Waste and Recycling Value[1]

MATERIAL	Annual Household Accumulations (Pounds)	Annual Household Energy Savings Equivalent - Recycling (Gallons of Gasoline)
PAPER		
Newspapers	233	11.2
Other Separable	173	8.3
Nonseparable	370	—
GLASS	368	3.7
FERROUS METALS	210	10.1
ALUMINUM	20	16.0
OTHER NONFERROUS	7	—
PLASTICS		
Separable	33	4.9
Nonseparable	77	—
RUBBER & LEATHER	33	—
TEXTILES	33	—
WOOD	20	—
FOOD	593	—
MISC. INORGANIC	33	—
SUBTOTAL	2,203	54.2
BULKY MATERIALS	213	—
YARD WASTES	600	—
TOTAL	3,016	54.2

3. Based on the chart in Problem 2, how many gallons of gasoline equivalents could you save in a week if you were to recycle whatever trash you could? In a year? Which trash items are presently unrecyclable?

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[1] Partial data taken from Energy In Solid Waste. Citizens' Advisory Committee on Environmental Quality, Washington, D.C., 1975, pg. 14.

THEME 6. ENERGY ALTERNATIVES

BACKGROUND

Alternative sources and uses of energy are analyzed in Theme 6 in relation to the search for solutions to the world-wide problem of fossil fuel energy shortages. Criteria for selection of future sources of energy are also identified. In addition, the relative advantages and disadvantages of a wide range of alternative energy sources and uses are evaluated.

This theme exphasizes the research and development of technology for utilizing inexhaustible and/or renewable energy sources such as solar, nuclear, geothermal, and biomass to supply and meet future energy demands. It also considers the scope of the search for energy alternatives in relation to the impact on the environment and the needs and interests of individuals and societies.

Theme 6 should make students aware that some of the earth's resources are limited and exhaustible. Therefore, our dependence on and demand for increasing amounts of fossil fuels must change if we are to maintain our present lifestyles. Students should be encouraged to support the research and development of alternative sources and uses of energy which are appropriate to their needs and lifestyles. They can also view and practice conservation as an energy alternative or part of the search and solution for more efficient uses of energy.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.

CORE THEME OBJECTIVE

To know alternative energy sources and uses.

Theme 6. Energy Alternatives

CONCEPTS

1. Future sources should have high energy potential, be retrievable, easily obtainable, economically feasible, efficient for conversion, safe, healthful and environmentally noncontaminating.
2. New energy sources are being studied for future use. Research is now being done to harness the following energy sources for the future:
   a. fossil fuels sources: oil shale, tar sands and coal gasification.
   b. natural or continuous sources: geothermal, solar tidal and wind.
   c. other sources: hydrogen, fuel cells, magnets, hydrodynamics, burning of trash, nuclear fission, breeder reactors and thermonuclear fusion.
3. The development and use of alternative energy sources will affect and be affected by the attitudes, values and lifestyles of individuals and societies.
4. Alternate energy sources indigenous to Hawaii include geothermal, ocean thermal energy conversion (OTEC), biomass, solar, wind and hydroelectricity.

135

Theme 6. Energy Alternatives

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 61 - Unit IX) Continued research and experimentation are required for advancement in agricultural productivity and human's well being.

ART: (pg. 7 - Objective) Use the potentialities of art and take action to shape and enhance the quality of one's personal and public environment.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) An understanding of how governments are similar to and different from our own in solving their problems.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objectives) 1. To live effectively in today's economic environment. 2. To meet the ever-changing demands of the business world of work.

HOME ECONOMICS: (pg. iii - Objective) Perform the tasks of maintaining a home in such a way that will contribute effectively to furthering individual and family goals.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop understanding of the importance and relevance of mathematics historically and in the world today.

SCIENCE: (pg. A-13 - Objective) Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to participate actively and responsibly in collective decisions affecting the social, economic, political, or physical environment in which he or she lives.

THEME 6. Energy Alternatives

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

*1. Compare the cost/benefits of a heat pump and a solar water heating system. (See Sample Activity 6-1. "Solar Cents?")

*2. Draw a parabola with a focal width of 10 units. Translate the parabola into a parabolic cooker. (See Sample Activity 6-2. "A Reflection of Energy.")

3. Calculate the comparative costs of different energy strategies (solar, oil, nuclear, conservation, etc.). Which alternative strategy seems to be the best? Why?

4. Make maps of the United States (include Alaska and Hawaii) depicting the amount of sunshine received (data available at the weather station). On your map, record the number of sunny days per year. Which regional area has the greatest number of sunny days per year? Which region has the least? Why is this information of value to scientists, engineers, and architects in determining the use of solar energy in a given region?

5. Investigate the feasibility of harnessing the wind as an energy source for use in Hawaii. What are the opportunity costs?

6. Investigate the recovery of wastes into a useable form of energy. Find out the status of HPOWER (Honolulu Project on Waste Energy Recovery). Does the study indicate a positive net energy return for a waste energy recovery system for Hawaii?

VOCABULARY

Aesthetics, alternate energy, biomass conversion, conservation, cost benefits, costs, insolation, opportunity costs, parabola, pollution, recycle, reflected light, solar energy, solar systems, solar tax credit, technology, waste energy recovery, wind energy.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Energy in Solid Waste. Citizens' Advisory Committee on Environmental Quality, Washington, D.C., 1975.
b. Energy Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.

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* For detailed description, refer to noted Sample Activity.

Note to teacher: (Cont'd.)

b. Hawaii Home Energy Book by Jim Pearson. The University Press of Hawaii and The Research Corporation of the University of Hawaii, Honolulu, Hawaii, 1978.

c. Annual reports published by the Hawaii Natural Energy Institute (HNEI), University of Hawaii at Manoa.

d. Legislative Energy RD&D Workshop Handbook. Hawaii State Senate, Economic Development and Energy Committee, State of Hawaii, November 1979.

e. Publications (pamphlets, leaflets, etc.) by the State Energy Office and the Department of Energy (Federal Energy Office).

f. Solar/Wind Handbook for Hawaii by Waqudi Falicoff, George Koide and Patrick Takahashi. U.S. Department of Energy in cooperation with University of Hawaii at Manoa, University of Hawaii at Hilo, and Department of Planning and Economic Development, State Energy Office, State of Hawaii, Honolulu, Hawaii, May 1979.

THEME 6. Energy Alternatives

Subject Area Math (Bus, HEc, IA, IT, Sc)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 6-1. "Solar Cents?"

OBJECTIVE

- To know alternative energy sources and uses.

CONCEPTS

- Future sources should have high energy potential, be retrievable, easily obtainable, economically feasible, efficient for conversion, safe, healthful and environmentally noncontaminating.
- New energy sources are being studied for future use. Research is now being done to harness the following energy sources for the future:
  a. fossil fuel sources: oil shale, tar sands and coal gasification.
  b. natural or continuous sources: geothermal, solar, tidal and wind.
  c. other sources: hydrogen, fuel cells, magnets, hydrodynamics, burning of trash, nuclear fission (breeder reactors) and thermonuclear fusion.
- Alternate energy sources indigenous to Hawaii include geothermal, ocean thermal energy conversion, biomass, solar, wind and hydroelectricity.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decision concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 6. Energy Alternatives

Sample Activity 6-1

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Z, Algebra IA)

- Adds, subtracts, multiplies, and divides rational numbers. (pg. 136)
- Understands the nature and use of a variable. (pg. 136)
- Understands the power and use of algebraic symbols. (pg. 136)
- Recognizes the relationship between the properties of the real numbers and algebraic techniques. (pg. 136)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 6.1.
2. Worksheet 6.1.

140

Theme 6. Energy Alternatives

Sample Activity 6-1

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 4, 5 & 14)

Strong public and governmental interest has recently been shown in the use of alternate energy sources for meeting Hawaii's needs. To date, the federal government is giving a 40% tax credit for solar water heaters, while the State (Hawaii) government offers a 10% tax credit.

Hawaii ranks high in comparison with other places in the continental U.S.A. in terms of availability of solar energy. Honolulu receives about 175 Kilowatt hours of energy on each square foot of earth per year. This is enough energy to run a 60 watt bulb 8 hours a day for an entire year. In areas of the island where insolation is not very high, heat pumps may be the answer. The disadvantage of heat pumps in terms of energy conservation is that a considerable amount of electricity (fossil fuel) is still used.

For residents of Hawaii who install a solar system costing $2,600 for a family of 3 people, the pay back period is about 7-9 years, depending on the income tax bracket and the length and interest rate of the loan. (This estimation is based on an estimated 10-18% inflationary rate for electricity and 10% tax credit from the State.)

For Hawaii, solar water heating is one energy-saving alternative that is feasible and practical.

In this activity students will compare the cost/benefits of a heat pump and a solar water heating system.

1. Discuss various energy alternatives with students. Discuss some of the alternate energy sources that are possible for Hawaii.
2. Discuss the solar water heating and heat pump systems with the students. Students should have a general idea of how each works. (A speaker representing both systems could be invited to speak to the class.)
3. Have students do Exercise 6.2.
4. Discuss Exercise 6.2.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Interview people who have a solar water heater and/or heat pump. Determine the average actual savings on utility bill for both systems. Compare your findings with the savings being advertised.

"Solar Cents"

Directions: Solve the problems below using the following information about Mrs. Ah Leong.

To conserve energy, Mrs. Ah Leong has decided to install a solar heating system in her home. The cost, excluding taxes and finance charge, is $4,000.00. This installation will reduce her utility bill 50%. Presently her utility bill averages $1,200.00 per year.

1. How much money will be saved yearly after the installation?

2. If the federal government provides a tax credit of 40% on the first $1,000.00 and 25% on the principal balance, what is the total tax credit provided by the federal government on the $4,000.000 system?

3. If Hawaii's state government provides a tax credit of 10% on the solar water heating system, what is the total tax credit provided by the State government on the $4,000.00 system?

4. How long will it take before the solar water system pays for itself? (Assume that the average utility bill will remain constant.)

5. If Mrs. Ah Leong installs a heat pump that costs $1,000.00 and yields savings of 30% of the annual utility bill, how long will it take before the heat pump pays for itself? (Assume she installs the heat pump instead of the solar water heater.)

142

Theme 6. Energy Alternatives Sample Activity 6-1

Exercise 6.1 (Cont'd.) Grade Level 9-12

6. Overall, which system (solar water heater or heat pump) conserves the most energy? Why?

7. At what point in time will the savings from the heat pump equal the savings from the solar water heater system?

Theme 6. Energy Alternatives Sample Activity 6-1

Worksheet 6.1 Grade Level 9-12

"A Possible Solution?"

Directions:
1. Solve the 30 problems below and on the next page.
2. In Table 1, find the two letters that correspond to your answer.
3. Choose one of the letters and write it in the blank that correspond to the problems.
4. As you work out the hidden message, you may wish to change the letters you've selected.
5. Example: To discover the first letter of the first word, solve problem (1) which is $2z + 15 = 7$. The answer is -4. From Table 1, you can see that -4 corresponds to letters "C" or "L." In this case, a "C" was chosen. (See dash number 1.)
6. When the secret message is solved, unscramble the letters that are circled. When the letters are unscrambled you will discover that the secret word refers to the basic source for most of our energy.

Table 1

1	-5	-2	-6	16	12	11
A/E	B/D	C/L	F/G	H/J	I/O	K/L

6	-3	4	5	-4	8
M/N	P/Q	R/S	T/W	U/Y	V/Z

Hidden Message:

C	_	_	○	_	_	_	_	_	○	_	○:
1	2	3	4	5	6	7	8	9	10	11	12

_	○	_	_	_	○	_	○	_	_	_	_
13	14	15	16	17	18	19	20	21	22	23	24

_	○	○	_	_	_.
25	26	27	28	29	30

Secret Message: __ __ __ __ __ __ __ __

1. $4z + 15 = 7$
   $z = \underline{-2}$

2. $\frac{2z}{3} = 8$

3. $3t + 5 = 23$

4. $2r + 3 = 11$

5. $\frac{2}{a} = 2$

6. $\frac{7r}{3} + \frac{2r}{3} = 12$

7. $\frac{3n}{4} = 6$

8. $x - (8 - x) = -6$

Worksheeet 6.1 (Cont'd.)

9. $\frac{-2y}{5} = -2$

10. $5y = 60$

11. $\frac{3}{4} K = 9$

12. $x - (8 - x) = 4$

13. $3a - (3 + a) = 7$

14. $\frac{z}{4} = 4$

15. $n - 1 = 0$

16. $6w - 3(w + 1) = 12$

17. $3t - 8 = t + 16$

18. $2z + 7 = 15$

19. $\frac{1}{2} y = .5$

20. $2z + 15 = 7$

21. $\frac{3}{4} n = 3$

22. $\frac{1}{4} n + \frac{3}{4} (4 + n) = 4$

23. $2x - 9 = 15$

24. $\frac{t}{3} - 5 = -7$

25. $5x = 5$

26. $\frac{1}{3} n = 2$

27. $3k + (6 - k) = 8$

28. $\frac{y}{4} - \frac{3y}{4} = -2$

29. $\frac{2t}{3} - \frac{1}{6}t = -3$

30. $\frac{3r}{4} + \frac{3r}{4} = -6$

Theme 6. Energy Alternatives Sample Activity 6-1

Worksheet 6.1 - Teacher's Answer Sheet Grade Level 9-12

"A Possible Solution?"

Directions:
1. Solve the 30 problems below and on the next page.
2. In Table 1, find the two letters that correspond to your answer.
3. Choose one of the letters and write it in the blank that correspond to the problems.
4. As you work out the hidden message, you may wish to change the letters you've selected.
5. Example: To discover the first letter of the first word, solve problem (1) which is $2z + 15 = 7$. The answer is -4. From Table 1, you can see that -4 corresponds to letters "C" or "L." In this case, a "C" was chosen. (See dash number 1.)
6. When the secret message is solved, unscramble the letters that are circled. When the letters are unscrambled you will discover that the secret word refers to the basic source for most of our energy.

Table 1

1	-5	-2	-6	16	12	11
A/E	B/D	C/L	F/G	H/J	I/O	K/L

6	-3	4	5	-4	8
M/N	P/Q	R/S	T/W	U/Y	V/Z

Hidden Message:

C	O	N	Ⓢ	E	R	V	A	T	Ⓘ	O	Ⓝ:
1	2	3	4	5	6	7	8	9	10	11	12

T	Ⓗ	E	W	I	Ⓢ	E	Ⓤ	S	E	O	F
13	14	15	16	17	18	19	20	21	22	23	24

E	Ⓝ	Ⓔ	R	G	Y.
25	26	27	28	29	30

Secret Message: S U N S H I N E

1. $4z + 15 = 7$
   $z = \underline{-2}$
2. $\frac{2z}{3} = 8$
   $z = \underline{12}$
3. $3t + 5 = 23$
   $t = \underline{6}$
4. $2r + 3 = 11$
   $r = \underline{4}$
5. $\frac{2}{a} = 2$
   $a = \underline{1}$
6. $\frac{7r}{3} + \frac{2r}{3} = 12$
   $r = \underline{4}$
7. $\frac{3n}{4} = 6$
   $n = \underline{8}$
8. $x - (8 - x) = -6$
   $x = \underline{1}$

Theme 6. Energy Alternatives

Sample Activity 6-1

Worksheeet 6.1 (Cont'd.)

Grade Level 9-12

Teacher's Answer Sheet

9. $\frac{-2y}{5} = -2$
   $y = \underline{5}$

10. $5y = 60$
    $y = \underline{12}$

11. $\frac{3}{4} K = 9$
    $K = \underline{12}$

12. $x - (8 - x) = 4$
    $x = \underline{6}$

13. $3a - (3 + a) = 7$
    $a = \underline{5}$

14. $\frac{z}{4} = 4$
    $z = \underline{16}$

15. $n - 1 = 0$
    $n = \underline{1}$

16. $6w - 3(w + 1) = 12$
    $w = \underline{5}$

17. $3t - 8 = t + 16$
    $t = \underline{12}$

18. $2z + 7 = 15$
    $z = \underline{4}$

19. $\frac{1}{2} y = .5$
    $y = \underline{1}$

20. $2z + 15 = 7$
    $z = \underline{-4}$

21. $\frac{3}{4} n = 3$
    $n = \underline{4}$

22. $\frac{1}{4} n + \frac{3}{4} (4 + n) = 4$
    $n = \underline{1}$

23. $2x - 9 = 15$
    $x = \underline{12}$

24. $\frac{t}{3} - 5 = -7$
    $t = \underline{-6}$

25. $5x = 5$
    $x = \underline{1}$

26. $\frac{1}{3} n = 2$
    $n = \underline{6}$

27. $3k + (6 - k) = 8$
    $k = \underline{1}$

28. $\frac{y}{4} - \frac{3y}{4} = -2$
    $y = \underline{4}$

29. $\frac{2t}{3} - \frac{1}{6} t = -3$
    $t = \underline{-6}$

30. $\frac{3r}{4} + \frac{3r}{4} = -6$
    $r = \underline{-4}$

THEME 6. Energy Alternatives

Subject Area Math (IA, IT, Sc)
Thematic Area EE, CE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 6-2. "A Reflection of Energy"

OBJECTIVE

- To know alternative energy sources and uses.

CONCEPTS

- Future sources should have high energy potential, be retrievable, easily obtainable, economically feasible, efficient for conversion, safe, healthful and environmentally noncontaminating.
- New energy sources are being studied for future use. Research is now being done to harness the following energy sources for the future:
  a. fossil fuel sources: oil shale, tar sands and coal gasification.
  b. natural or continuous sources: geothermal, solar, tidal and wind.
  c. other sources: hydrogen, fuel cells, magnets, hydrodynamics, burning of trash, nuclear fission (breeder reactors) and thermonuclear fusion.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Z, Analytic Geometry)

- Given conditions on a conic section, determines its equation. (pg. 154)

Theme 6. Energy Alternatives

Sample Activity 6-2

Grade Level 9-12

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 6.2.
2. Materials for the construction of a parabolic cooker as listed on pg. 146.

Theme 6. Energy Alternatives

Sample Activity 6-2

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 4, 5, & 14)

People living in prehistoric times probably realized that the sun was essential for life, giving off heat and light. To show the importance of the sun, many cultures such as the Aztecs, Incas, Egyptians, etc., identified the sun as being a god, the creator of life on earth.

Direct use of solar energy has been practiced since the beginning of agriculture where it was used for drying foods and growing fruits, vegetables, and other crops. The Aztecs used solar energy to dry clay pottery and vessels.

In 212 B.C., a Greek philosopher by the name of Archimedes used solar energy in a military confrontation between Greek soldiers and an invading Roman fleet. It is believed that the Greek soldiers lined up along the harbor and using their shields, reflected the sunlight onto the invading Roman fleet. The high concentration of sunlight produced enough heat to set the warships on fire.

Today the principle of reflection is used to gather and concentrate the sun's heat on a specific point. The unique properties of a parabola allows it to concentrate the sun's light to a point. If a smooth, shiny surface such a metal or a mirror is shaped into a parabola, the heat captured from the sun could be used to cook food. A cooker such as the parabolic cooker can focus the sun's rays, increasing the heat concentrated by 20 to 100 times. If the sun's energy can be harnessed to do useful work, it may be one of the alternative energy sources to supplement and/or replace the fossil fuel energy used in the home.

In this activity students will construct a parabolic cooker using their mathematical skills.

1. Review and/or discuss the properties of a parabola with the students. Ask students if they know how a parabola could be used to capture and concentrate the sun's rays.
2. Distribute Exercise 6.2 and have students construct a parabolic cooker. (Note: Students may be given the following information to construct their parabola if necessary: a) the focal width of the parabola with equation $x^2 = 4py$ is $|4p|$; or b) the focal width of a parabola with equation $y^2 = 4px$ is $|4p|$.
3. After students have constructed their parabolic cooker, have them test it out.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Design and construct your own geometric design for a working solar cooker.

Theme 6. Energy Alternatives

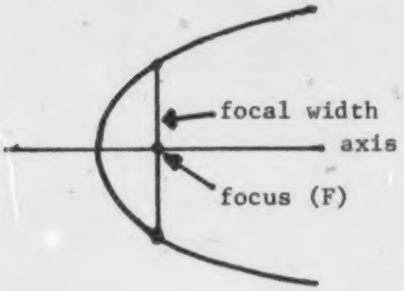
Exercise 6.2

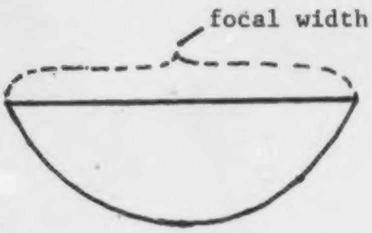
Sample Activity 6-2

Grade Level 9-12

"A Reflection of Energy"

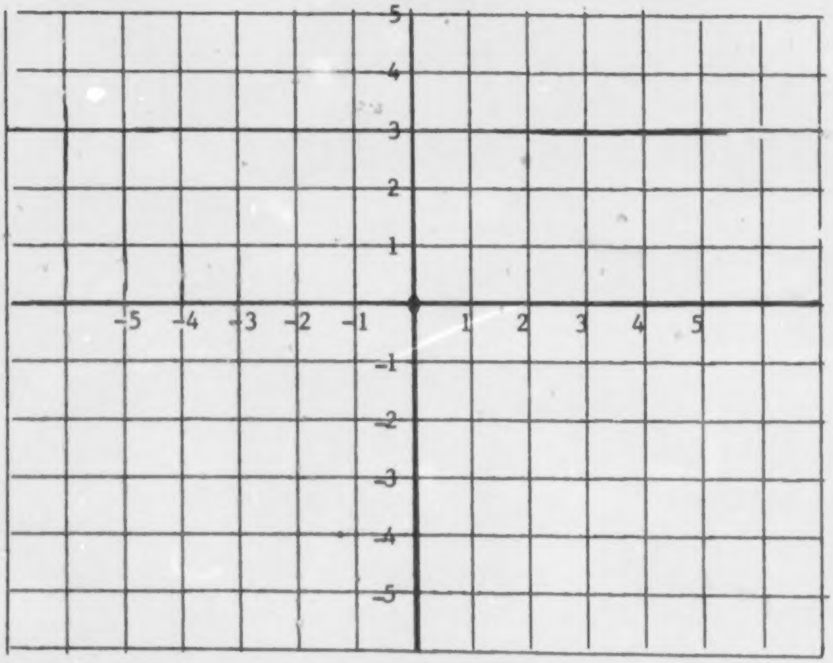
The unique properties of a parabola can be used to concentrate the sun's rays to a given point called the focus (F) of the parabola. (See Diagram A below.) Using the parabola's properties, a parabolic cooker can be constructed.





PART I: Graphing A Parabola

Directions: Draw a parabola such that the focal width is 10 units.



PART II: Constructing A Parabolic Cooker

Directions: (1) Using the parabola that you constructed in Part I, let each unit stand for one inch. Next make a pattern of your parabola on a piece of paper. (The focal width should be 10 inches.)

(2) Next, gather the items listed under Materials.

Materials: Aluminum foil, cardboard, oak tag paper, glue, barbecue sticks, tape, and solar foil (or foil painted black on one side).

Procedure:

1. Trace your parabolic figure on a piece of hard cardboard. Cut out two such pieces. (See Diagram B.)

2. Use oak tag and cut out a rectangular piece to fit the curvature of your parabolic figure. (Use aluminized cardboard paper if available, and omit step 3.*) Make the width of the rectangular piece 6 inches.

3. Carefully cover one side of the rectangular piece of oak tag with aluminum foil. Be sure that the foil has little or no creases. If there are creases, smooth them out. (Adhesive back mylar may be used instead of foil.*

4. Attach the aluminum-covered side of the oak tag to the curved edges of the parabolic-shaped pieces with tape or glue. (See Diagram C.) Your cooker should resemble a rocking chair.

5. Finish up the cooker as shown in Diagram C.

6. Stick a small pin into the cardboard near the barbecue stick. (See Diagram C.) This pin is used to position the cooker to collect the maximum amount of sunlight. When the cooker is properly positioned, the pin should cast no shadow.

7. Use the barbecue stick as a skewer for a hot dog. Cover the hot dog with the solar foil. The black side of the foil should be on the outside. Why?

8. Place the barbecue stick with the hot dog in the parabolic cooker. If you have calculated the parabola correctly, your hot dog should be hot in 10-15 minutes on a nice, hot, sunny day.

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*Available for Edmund Scientific.

Theme 6. Energy Alternatives

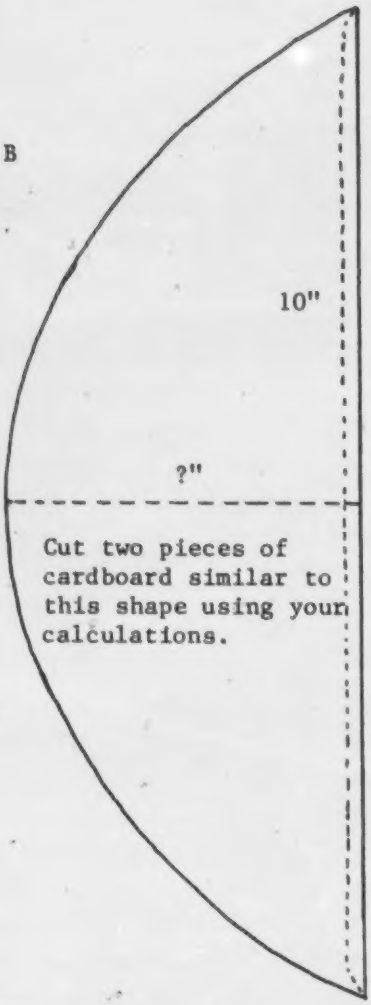
Exercise 6.2 (Cont'd.)

Sample Activity 6-2

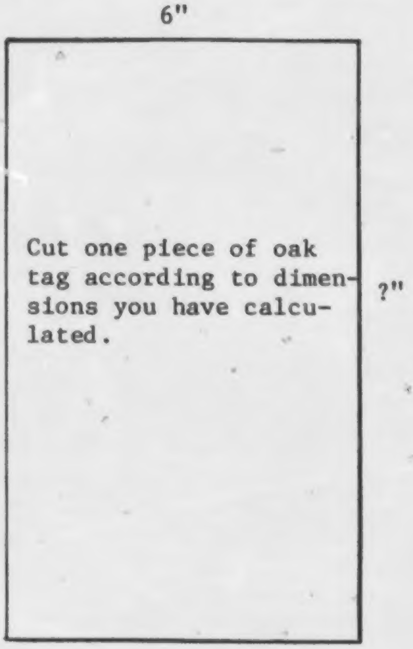
Grade Level 9-12

"Parabolic Cooker"

Diagram B

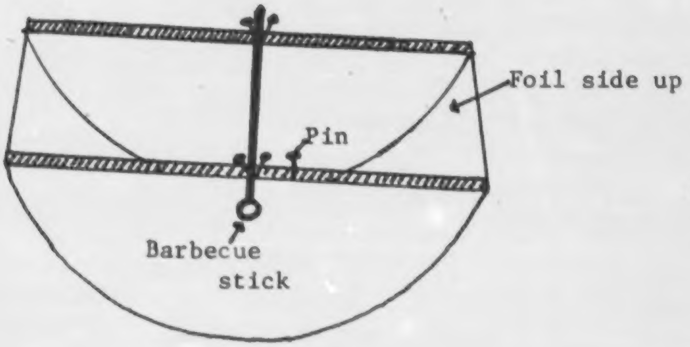


Cut two pieces of cardboard similar to this shape using your calculations.



Cut one piece of oak tag according to dimensions you have calculated.

Diagram C



THEME 7. ENERGY STORAGE AND TRANSMISSION SYSTEMS

BACKGROUND

Theme 7 deals with the need for efficient systems to store available energy sources in a form that can be readily used and to transmit the energy to appropriate locations at a time when it is actually needed. The main purpose of these storage and transmission systems is to improve the efficiency of the flow of energy from the source to the consumer.

The efficient storage of energy in fossil fuels and readily available transport systems resulted in tremendous consumption of this energy source. However, as the limits of fossil fuels are being realized, modern technological societies must seek alternative energy sources. These resources have to be extracted, converted to a useful form, and stored until they are needed and used.

Some problems associated with the technology of improving storage to meet constantly increasing demands of consumers for more energy involve storage of large quantities of energy and the matching of intermittent sources with intermittent consumption.

This theme can help students to view the improvement of storage and transmission systems as an alternative energy source in the sense that increasing amounts of energy can be made available through more efficient use of current and/or future energy sources. It will also make them aware of the interaction of science and technology with the societal acceptance of solutions to energy-related problems.

FOUNDATION PROGRAM OBJECTIVES

- FPO 1. Develop basic skills for learning and effective communication with others.
- FPO 2. Develop positive self-concept.
- FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
- FPO 4. Develop independence in learning.

CORE THEME OBJECTIVE

To know various energy storage and transmission systems.

Theme 7. Energy Storage and Transmission Systems

CONCEPTS

1. There are ethical, legal, aesthetic, social, political, economic, biological, and physical benefits and costs associated with energy storage and transmission systems.
2. Storage and transmission systems must be complementary to each other and appropriate to a given energy source.
3. In Hawaii, research of storage and transmission systems being done by the Hawaii Natural Energy Institute (HNEI) will lead to concepts useful in designing such systems.

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

HOME ECONOMICS: (pg. iii - Objective) Perform the tasks of maintaining a home in such a way that will contribute effectively to furthering individual and family goals.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

MATHEMATICS: (pg. 13 - Goal) Develop understanding of the importance and relevance of mathematics historically and in the world today.

SCIENCE: (pg. A-13 - Objectives) 1. Foster the students' appreciation for the practical and aesthetic contribution of science to the improvement of quality of life and to promote in our students the desire to take an active part in that contribution. 2. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to participate actively and responsibly in collective decisions affecting the social, economic, political, or physical environment in which he or she lives.

155

THEME 7. Energy Storage and Transmission Systems

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. Investigate various forms of energy transmission and compare the feasibility of each. What are the cost/benefits of each transmission system?

2. Compare the various levels of storage capabilities of various objects such as a wound up clock, a flywheel, a gallon of gasoline, etc. What are their energy densities (watt hours per pound)? See Energy Self-Sufficiency for the State of Hawaii by University of Hawaii Students of Civil Engineering/Interdisciplinary Studies, University of Hawaii at Manoa, Honolulu, Hawaii, September 1978, pgs. 53-60.

3. A storage alternative used to harness the wind is the pumped storage system. The amount of energy stored would depend on the water capacity of the reservoir, the pressure produced by the water, and the efficiency of the generating system. Calculate the size of a reservoir or the amount of water needed to generate enough electricity for a household which uses 32 KWH per day.

4. Investigate the feasibility of linking the islands of Maui, Molokai, and Lanai with submarine electrical power cables. What is the cost estimate per mile of cable?

VOCABULARY

Batteries, cost/benefits, energy densities, pumped storage, storage, transmission.

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[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Solar/Wind Handbook for Hawaii by Waquidi Falicoff, George Koide, and Pat Takahashi. U.S. Department of Energy in cooperation with University of Hawaii at Manoa, University of Hawaii at Hilo, and Department of Planning and Economic Development, State Energy Office, State of Hawaii, Honolulu, Hawaii, May 1979.
b. Energy Self-Sufficiency for the State of Hawaii by University of Hawaii Students of Civil Engineering/Interdisciplinary Studies, published through a grant from the National Science Foundation, University of Hawaii at Manoa, Honolulu, Hawaii, September 1978.
c. Publications (leaflets, brochures and/or pamphlets) by the U.S. Department of Energy. Available locally from the Federal Energy Office.

THEME 8. TRANSPORTATION

BACKGROUND

Theme 8 considers transportation in terms of the movement of goods and people. It also focuses on the enormous amounts of energy currently being used.

The transportation system in the United States uses about half of the nation's total consumption of petroleum. Being the greatest consumer of petroleum, it could also become the greatest conserver of energy. To do this, more efficient cars and trucks could be made, alternative ways to travel and move goods could be promoted, drivers could be taught to save gas, and other wasteful habits could be changed.

This theme should enable students to realize that the cost of energy continues to increase while the sources of petroleum energy dwindle. Alternative modes of transportation as well as trade-offs between transportation and communication systems must be considered. They should also be aware of the possible need for changes in personal values and lifestyles to accommodate various transportation modes.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 5. Develop physical, social and emotional health.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.

CORE THEME OBJECTIVE

To know a wide range of transportation modes and their energy resource requirements.

CONCEPTS

1. One of the major users of energy is transportation.
2. Transportation modes should be appropriate to the needs of moving people and/or goods.
3. Transportation modes should be improved to make more efficient use of energy sources and have minimum negative effects on the environment.
4. Research of the potential of communications systems may help to relieve pressure on energy supplies used for transportation. It is far less costly to move information than to move people and things.
5. The Hawaii State Plan calls for an integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe and convenient movement of people and goods.

Theme 8. Transporation

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 58 - Unit VI) Efficient processing, marketing, and distribution are essential in making agricultural products economically available to human.

ART: (pg. 7 - Objective) Demonstrate the application of necessary art skills and concepts by producing works of art in various modes of expression such as drawing, painting, ceramics, printmaking, weaving, sculpture and photography.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) A knowledge and understanding of the customs and mores of a society reflected in the student's behavior when living among the foreign group.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To develop an awareness of the needs of society for goods and services and how goods and services are effectively provided.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HEALTH: (pg. iii - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experiences contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objectives) 1. Develop an understanding of the principles, concepts, and problems of industrial technology. 2. Develop an understanding of the nature and significance of materials, tools, processes, products, and occupations of our technological world and their impact upon our society.

LANGUAGE ARTS: (pg. 4 - Goal) To increase student understanding of the nature and structure of the English language within the broad perspective of communication.

MATHEMATICS: (pg. 13 - Goal) Develop mathematical competence to function effectively in today's society.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Foster the students appreciation for the practical and aesthetic contribution of science to the improvement of quality of life and to promote in our students the desire to take an active part in that contribution. 2. Facilitate the students' ability to use scientific knowledge, processes, instruments and scientific language to clarify values, examine issues, solve problems in fulfilling personal, social and career life roles. 3. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

SOCIAL STUDIES: (pg. 16 - Objectives) 1. The student is able to clarify value conflicts of communication problems which affect choices, decisions, or relationships. 2. The student is able to construct, evaluate, and revise alternatives for personal goals, plans or problems solutions, considering costs and benefits to self and to others affected by his or her decisions.

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

*1. Investigate the driving habits of Hawaii's motorist by finding out the number of registered vehicles, the gasoline consumed, and the the average number of miles traveled. (See Sample Activity 8-1. "Moving Right Along.")

*2. Find out how energy can be conserved by proper planning and sensible driving habits. (See Sample Activity 8-2. "Gas and Go.")

3. Keep a record of the number of times (per week) trips from home have been made in the family car when, with planning, one trip might have been sufficient. Compile the class results and devise a plan for reduction of travel. Compute the class totals or averages of unnecessary mileage before and after a conservation plan is implemented. Show your comparisons on a bar graph.

4. Pretend that you are going on a two-week camping trip "x" miles from home. Wishing to spend as little money as possible and contribute to as little pollution as necessary, what mode of travel, cooking fuel, housing, and equipment would you use? What kinds of activities would you plan? Calculate the possible dollars and energy saved.

5. Calculate the gasoline conserved if certain driving habits were changed. Make a list of the "old" driving habits and a list of the new ones. Compare fuel consumption of "old" and "new" driving habits.

6. Calculate the miles per gallon (fuel economy) of your own car or your family's car. Also calculate the cost per mile. (Be sure to consider such costs as oil, gasoline, maintenance, service, etc.)

7. Maintain an "idling log" for one week. How much fuel was consumed while your engine was idling? How long do you idle at a red traffic light? Find out how much fuel is consumed by a car idling for one minute. Call the State Energy Office or consult a mechanic or the shop teacher at your school.

8. Calculate the number of barrels of oil consumed by the air transportation sector of your community. Compare the oil consumption of inter-island transportation and foreign and domestic travel.

VOCABULARY

Alternatives, car, car pool, conservation, fuel consumption, fuel economy, environmental impact, mileage, pollution, technology, transportation modes, values.

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* For detailed description, refer to noted Sample Activity.

Theme 8. Transportation

Subject Area Mathematics

Grade Level 7-12

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Tips for Energy Savers. U.S. Department of Energy. Washington, D.C., September 1978.
b. Hawaii Home Energy Book by Jim Pearson. The University Press of Hawaii and The Research Corporation of the University of Hawaii, Honolulu, Hawaii, 1978.
c. Energy Use in Hawaii. Department of Planning and Economic Development, State Energy Office, State of Hawaii, November 1977.
d. Energy Conservation in Hawaii. Department of Planning and Economic Development. State Energy Office, State of Hawaii, 1977.
e. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.
f. 16 Steps to Conserve Energy on Our Highways. North Carolina Department of Public Instruction. Division of Science Education, Raleigh, North Carolina, February 1974.

THEME 8. Transportation

Subject Area Math (LA, Sc)
Thematic Area EE, G, LS, VE
Grade Level 7-8

SAMPLE ACTIVITY 8-1. "Moving Right Along"

OBJECTIVE

- To know a wide range of transportation modes and their energy resource requirements.

CONCEPTS

- One of the major users of energy is transportation.
- Transportation modes should be appropriate to the needs of moving people and/or goods.
- Transportation modes should be improved to make more efficient use of energy sources and have minimum negative effects on the environment.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 6. Read and use scales on standard measuring devices.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)

MATHEMATICS PROGRAM LEARNER OBJECTIVES

- Reads, writes (using words and symbols) and verbalizes mathematical ideas in order to communicate quantitative information. (pg. 94)
- Rounds numbers to a designated value. (pg. 95)
- Adds, subtracts, multiplies, and divides whole numbers. (pg. 96)
- Adds, subtracts, multiplies,and divides decimals. (pg. 98)
- Solves percent problems. (pg. 98)
- Uses appropriate tools and units to measure objects. (pg. 100)

Theme 8. Transportation

Sample Activity 8-1

Grade Level 7-8

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 8.1.
2. Worksheet 8.1.

Sample Activity 8-1
Grade Level 7-8

ACTIVITY (Related Core Themes: 1, 3, 4 & 5)

It has been estimated that a typical car with an average fuel economy of less than 15 miles per gallon uses about 650 gallons of gasoline each year. (These figures are based on an average of 10,000 miles per year per car as estimated by the Department of Energy in March 1978.) If just one gallon of gasoline were saved each week for every automobile in the United States, the saving would amount to approximately 5.6 billion gallons of gasoline a year, which is about 8% of our current demand for gasoline for passenger cars.

In this activity, students will practice basic mathematical skills while doing energy mathematics problems.

1. As a review of problem solving skills involving decimals and percents, have students do Exercise 8.1.
2. After completing the exercise, discuss the role of mathematics in everyday life and in energy mathematics.
3. As a review of computational skills with decimals, have students do Worksheet 8.1.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Call the Department of Planning and Economic Development, State Energy Office, and find out the latest statistics about Hawaii's motorist. Calculate the average miles per gallon.

Theme 8. Transportation

Sample Activity 8-1

Exercise 8.1

Grade Level 7-8

"From Here To There"

Directions: Using the data from Tables 1 and 2, on the pages that follow, answer the following questions. Express your answers to the nearest tenth place.

1. What was the total number of vehicles in 1960?

2. In 1970, what was the average number of miles traveled per vehicle?

3. In 1960, what was the average mileage for each vehicle? (Hint: to find mileage divide distance travelled by gallons of gasoline used.) Do you think the average mileage for vehicles registered in Hawaii today is the same? Why or why not?

4. The number of passenger cars between 1960 and 1976, increased by how many? What multiple did it increase by? Express your answer as a decimal to the nearest tenth place.

5. Calculate the average number of gallons of gasoline used by each vehicle in each of the three years. Did the amount of gasoline consumed per vehicle increase or decrease? What was the percentage increase or decrease?

6. What did the average motorist pay for a year's supply of gasoline in 1960? in 1970? in 1975?

7. If Hawaii's motorists cut back their driving by 0.25, how many gallons of gasoline would each vehicle save (on the average)? (Use the 1976 data.) How much money would each driver save if gasoline cost $1.39 per gallon?

Theme 8. Transportation — Sample Activity 8-1

Exercise 8.1 — Grade Level 7-8

"From Here To There"

Table 1. Gasoline Consumption, State of Hawaii*

Year	Motor Vehicle Registration[a]		Highway Fuel Consumption[b] (total in 1000 gallons)	Vehicle Miles of Travel[c] (total in millions of miles)
	Number of Passenger Cars	Other Motor Vehicles		
1960	199,200	31,000	142,100	1,990
1970	358,200	46,200	243,500	3,410
1976	462,700	73,800	308,200	4,310

[a] Excludes military vehicles, motorcycles, motor scooters, trailers, and semi-trailers.

[b] Includes gasoline, diesel oil, and butane gas.

[c] Based on average of 14 miles per gallon.

Source: Hawaii State Department of Transportation.

Table 2. Motor Gasoline Prices* (per gallon)

Year	Continental United States (cents)[a]	Oahu (cents)[b]
1960	31.1	42.1
1970	35.7	42.9
1976	58.7	71.9

[a] Pratt's Oilgram Price Service and Lundberg Survey conducted for FEA.

[b] State Energy Office.

Source: Department of Planning and Economic Development, Hawaii.

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* Figures rounded off.

Theme 8. Transportation

Worksheet 8.1

Sample Activity 8-1

Grade Level 7-8

"On the Go"

Directions:
1. Do each of the 20 problems below.
2. In Table 1, find the letters that correspond to your answers.
3. Write the letters in the blanks that correspond to the problems.
4. Unscramble the circled letters in the secret message line to find out the secret word.

Example: To discover the first letter of the first word, solve problem (1) which is 0.04 + 0.11 = 0.15. From Table 1 you can see that 0.15 corresponds to the letter "C." The letter in the first blank should therefore be "C."

Table 1.

A	B	C	D	E	F	G	H	I	J	K	L	M
3.401	0.36	0.15	4.014	2.7	0.25	90.0	0.144	0.945	165.0	0.12	59.99	3.98

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
210.0	2.69	0.103	12.0	83.5	1.8	0.084	0.872	2.6	3.5	0.01	0.025	2.33

Secret Message:

○C 1 ___ 2 ○ 3 ___ 4 ○ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10

○ 11 ___ 12 ○ 13 ○ 14 ___ 15 ○ 16 ○ 17 ___ 18 ___ 19 ___ 20

Secret Word: ___ ___ ___ ___ ___ ___ ___ ___

Problems:

1) 0.04 + 0.11 = 0.15

2) 0.201 + 3.2

3) 3.7 + 71.53 + 8.27

4) 0.026 + 0.077

5) 2.6 + 0.09

6) 4.54 - 1.85

7) 303 - 243.01

8) 3.456 - 0.055

9) 225.35 - 15.35

10) 7.04 - 3.026

11) 36 x 0.05

12) 17005 x 0.0002

13) 5.2 x 0.5

14) 0.03 x 90

15) 3 x 0.9

16) $0.069\overline{)14.49}$

17) $0.5\overline{)1.35}$

18) $3.6\overline{)300.6}$

19) $0.25\overline{)22.5}$

20) $128\overline{)3.2}$

Theme 8. Transportation

Sample Activity 8-1

Worksheet 8.1

Grade Level 7-8

Teacher's Answer Sheet

"On the Go"

Directions:
1. Do each of the 20 problems below.
2. In Table 1, find the letters that correspond to your answers.
3. Write the letters in the blanks that correspond to the problems.
4. Unscramble the circled letters in the secret message line to find out the secret word.

Example: To discover the first letter of the first word, solve problem (1) which is .04 + .11 = .15. From Table 1 you can see that .15 corresponds to the letter "C." The letter in the first blank should therefore be "C."

Table 1.

A	B	C	D	E	F	G	H	I	J	K	L	M
3.401	.36	.15	4.014	2.7	.25	90.0	.144	.945	165.0	.12	59.99	3.98

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
210.0	2.69	.103	12.0	83.5	1.8	.084	.872	2.6	3.5	.01	.025	2.33

Secret Message:

Ⓒ	A	Ⓡ	P	Ⓞ	O	L	A	N	D
1	2	3	4	5	6	7	8	9	10
Ⓢ	A	Ⓥ	Ⓔ	E	Ⓝ	Ⓔ	R	G	Y
11	12	13	14	15	16	17	18	19	20

Secret Word: C O N S E R V E

Answers:

1) 0.15
2) 3.401
3) 83.5
4) 0.103
5) 2.69
6) 2.69
7) 59.99
8) 3.401
9) 210.00
10) 4.014
11) 1.8
12) 3.4010
13) 2.6
14) 2.7
15) 2.7
16) 210
17) 2.7
18) 83.5
19) 90
20) 0.025

THEME 8. Transportation

Subject Area Math (IT, Sc)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 8-2. "Gas and Go"

OBJECTIVE

- To know a wide range of transportation modes and their energy resource requirements.

CONCEPTS

- One of the major users of energy is transportation.
- Transportation modes should be improved to make more efficient use of energy sources and have minimum negative effects on the environment.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Core Algebra)

- Performs the four basic operations with simple rational expressions (pg. 126)
- Given a verbal problem, writes an appropriate equation, solves the equation, interprets the problem in terms of the problem setting. (pg. 127)
- Applies formulas that arise from real-world situations. (pg. 128)

SUGGESTED MATERIALS AND/OR RESOURCES

Exercise 8.1.

Theme 8. Transportation

Sample Activity 8-2
Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 3, 4, 5 & 10)

Passenger automobiles consume about 14% of all the energy and about 31% of all the petroleum used in the United States. (Although passenger automobiles also consume about 14% of the energy used in Hawaii, this represents only 16% of the petroleum consumed in Hawaii since 92% of our source of energy is from petroleum.)

In 1975, it was estimated that in the 50 states, there were 100,000,000 registered automobiles, with an average fuel economy of 13.7 miles per gallon, or 5.8 kilometers per liter. Based on the 1975 figures, it was estimated by the Federal Energy Administration (FEA) that if fuel consumption is reduced 15% through better car maintenance, the nation's consumption of petroleum could be decreased by over 28,000,000 gallons per day or 1.02×10^{10} gallons per year.

The potential savings of energy can help stretch our current fuel supply, save money, reduce pollution and provide valuable time for research and development.

In this activity, students will use algebraic skills in solving problems involving the automobile.

1. Discuss the automobile and the energy necessary to make it work.
2. Discuss some possible conservation measures automobile owners and drivers can practice to increase the car's fuel economy.
3. Distribute Exercise 8.1.
4. Discuss Exercise 8.1.

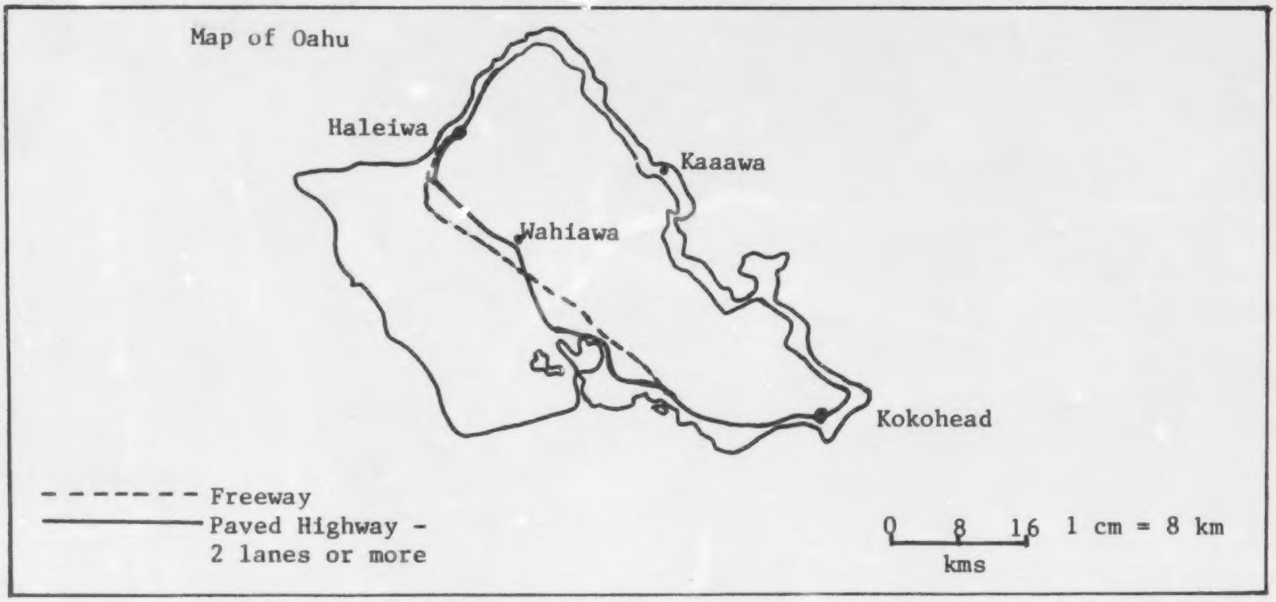
SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Investigate the efficiency of gasohol and diesel fuel and compare the cost benefits of each. Calculate Mr. Honda's savings or losses if he switched to (a) diesel fuel and/or (b) gasohol. (See Exercise 8.2.)

Theme 8. Transportation   Sample Activity 8-2

Exercise 8.1 - "Gas and Go"   Grade Level 9-12

Mr. Audi Honda owns a 1975 Slincoln Scontinental which averages 6.32 kilometers per liter (15 miles per gallon) of gasoline when driven 104 kilometers (65 miles) per hour, and 7.16 kilometers per liter (17 miles per gallon), when driven 88 kilometers (55 miles) per hour. Mr. Honda drives every day from Kokohead to Haleiwa where he works.



Directions: Using the Map of Oahu above, answer the following questions.

1. If Mr. Honda drove from Kokohead to Haleiwa, using the coastal highway through Kaaawa, what distance in kilometers did he travel? What was the distance in miles? (Hint: 1 kilometer = 0.6 mile)

2. If Mr. Honda drove back to Kokohead using the inland highway through Wahiawa, how many liters of gasoline did he use if he drove 88 kilometers per hour? (Answer to the nearest tenth of a liter.)

3. If Mr. Honda decided to use the freeway instead of the two highways, how many liters of gasoline would he consume if he drove 88 kilometers per hour? 104 kilometers per hour? How many liters of gasoline would Mr. Honda save by driving 88 kilometers per hour instead of 104 kilometers per hour? What percentage savings would this be?

Theme 8. Transportation   Sample Activity 8-2

Exercise 8.2 - "Gas and Go" (Cont'd.)   Grade Level 9-12

4. How much money would Mr. Honda save by driving at the slower rate of speed if gasoline costs $.37 per liter? (Assume that Mr. Honda used the freeway for his round trip.)

5. How long would Mr. Honda take to drive from Kokohead to Haleiwa and back at 88 kilometers per hour (55 miles per hour) if he used the freeway? How much time would he save if he drove at a speed of 104 kilometers per hour (65 miles per hour)? What would it cost per minute if the price of gasoline is $0.37 per liter?

6. If Mr. Honda forms a car pool with 3 others, and used the freeway each time it was his turn to drive, how much gas would he save in a month? What would be the percentage savings for a year? How much money would be saved in a month? A year? (Assume 20 working days per month and a cost of $.37/liter for gasoline.)

7. How else can Mr. Honda conserve gas? Energy?

THEME 9. ENVIRONMENTAL/ECOLOGICAL CONSIDERATIONS

BACKGROUND

The impacts of energy use on the environment are examined in Theme 9. These include the environmental damage resulting from the production, transportation and utilization of energy.

As energy consumption has increased, so has environmental pollution. In other words, environmental quality has been traded off for rapidly increasing demands for energy.

Various energy alternatives are being developed to meet energy demands as the shortage of fossil fuels is becoming more evident. Various energy sources have differing impacts on the environment while some uses of energy are more threatening than others to the environment. Therefore, advantages of a particular kind of energy extraction and/or use must be weighed against its effects on the environment.

Theme 9 will help to make students aware of the interrelationships among the principal variables of human ecology--population, organization, environment and technology which constitute an ecosystem. It will also help them to realize that every decision made involving energy alternatives affects the quality of life and must be considered in terms of its effect on the existing environmental and ecological conditions.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 5. Develop physical, social and emotional health.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To know various energy options and their environmental/ecological benefits and consequences.

Theme 9. Environmental/Ecological Considerations

CONCEPTS

1. Energy extraction and use alter and/or pollute natural environmental conditions.
2. Trade-offs are necessary to resolve conflicts over energy use and the environment.
    - a. A balance between short-term economic gains and long-term environmental quality involves trade-offs.
    - b. The resolution of conflicts over conservation, land use, ecologically sound practices and aesthetic judgments involves trade-offs.
3. Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of energy resources and their effects on the environment.
4. The Hawaii State plan states that the development or expansion of power systems and sources should adequately consider environmental, public health, and safety concerns and resource limitations.

174

Theme 9. Environmental/Ecological Considerations

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 59 - Unit VII) Agriculture is faced with environmental problems that are both internal and external.

ART: (pg. 7 - Objective) Use the potentialities of art and take action to shape and enhance the quality of one's personal and public environment.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) A knowledge and understanding of the customs and mores of a society reflected in the student's behavior when living among the foreign group.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HEALTH: (pg. iii & 1 - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experiences contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Create a home and community environment conducive to the healthy growth and development of all members of the family at all stages of the family cycle.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an understanding of the nature and significance of materials, tools, processes, products, and occupations of our technological world, and their impact upon our society.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Nurture intellectual curiosity and promote the desire to continue learning.

MUSIC: (pg. 2 - Objective) Use musical skills in communicating ideas, thoughts and feelings.

PHYSICAL EDUCATION: (pg. 106 - Objective) Learn to respect the rights of others, help the less-skilled players, subordinate their own desires to the will of the group, and realize that they have the responsibility of directing their actions in behalf of the group.

SCIENCE: (pg. A-13 - Objectives) 1. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated. 2. Encourage students to maintain a safe and healthy environment.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to participate actively and responsibly in collective decisions affecting the social, economic, political, or physical environment in which he or she lives.

THEME 9. Environmental/Ecological Considerations

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

*1. Find out how much money is spent yearly on the clean-up programs for water, air and solid waste. How much air pollutants are emitted each year? (See Sample Activity 9-1. "The Cost of Clean Living.")

*2. The use of paper and paper products in our modern society has increased so dramatically that paper is now in short supply. Find out how much paper ends up in the municipal solid waste. How much paper is recycled each year? (See Sample Activity 9-2. "Paper Profits.")

*3. The serious health, property, and environmental problems that have become such major and critical issues today began to surface when we started to use fossil fuels extensively. What are some of the environmental/ecological problems associated with energy use? (See Sample Activity 9-3. "A Likely Occurrence.")

4. Devise various means of measuring air pollution in your school. Use your device and take some measurements. Using the same device, measure the air pollution in your immediate neighborhood. How does the amount of air pollutants in your neighborhood compare with the air pollutants in the school's environment.

5. Design and sketch your concept of a system that could convert waste materials to heat energy for buildings. Assume the system will burn 360 tons of solid waste a day and allow for expansion to burn 1,500 tons a day.

VOCABULARY

Cause and effect, continuity, cost/benefits, ecology enviroment, environmentalist, HPOWER (Honolulu Project on Waste Energy Recovery), municipal waste, pollution, recycle, smog, trade-offs, value.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Energy in Solid Waste. Citizens' Advisory Committee on Environmental Quality, Washington, D. C., 1975.

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* For detailed description, refer to noted Sample Activity.

Theme 9. Environmental/Ecological Considerations

Subject Area Mathematics

Grade Level 7-12

Note to teacher: (Cont'd.)

b. Materials and Energy from Municipal Waste. Resource Recovery and Recycling from Municipal Solid Waste and Beverage Container Deposit Legislation, Congress of United States, Washington, D. C., July 1979.
c. Ecoscience: Population, Resources, Environment by Paul and Anne Ehrlich and John Holdren. W. H. Freeman and Co., San Francisco, California, 1977.
d. Publications (brochures, pamphlets, etc.) from the EPA (Environmental Protection Agency).
e. Publications (brochures, pamphlets, etc.) from the Department of Health.

THEME 9. Environmental/Ecological Considerations

Subject Area Math (H, LA, SS, Sc
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 9-1. "The Cost of Clean Living"

OBJECTIVE

- To know various energy options and their environmental/ecological benefits and consequences.

CONCEPTS

- Energy extraction and use alter and/or pollute natural environmental conditions.
- Trade-offs are necessary to resolve conflicts over energy use and the environment.
  a. A balance between short-term economic gains and long-term environmental quality involves trade-offs.
  b. The resolution of conflicts over conservation, land use, ecologically sound practices and aesthetic judgments involves trade-offs.
- Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of energy resources and their effects on the environment.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 13. Demonstrate knowledge of the basic structure and functions of national, state and local governments.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will demonstrate an appreciation for the interdependence of living things in the closed earth system. (Goal: pg. D30)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option X, Level B)

- Solves ratio, proportion, and percent problems. (pg. 124)
- Adds, subtracts, multiplies, and divides integers. (pg. 124)
- Applies equation solving techniques to verbal problems. (pg. 124)
- Understands and uses the relationship among common fractions, decimals, and percents. (pg. 124)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 9.1.
2. Worksheet 9.1.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 3, 4, 5 & 10)

As energy consumption has increased over the years, so has environmental pollution. Americans have traded environmental quality for a disposable, "throw-away" society.

Various energy sources and users have differing impacts on the environments. The opportunity costs of each energy source must be carefully weighed against its effects on the environment.

Each decision made by the energy user will also affect the environment. The citizenry must be informed of the possible effects of various actions so that he/she may be able to make wise decisions regarding energy use.

In this activity, students will learn more about the environment using basic math skills involving fractions, percents, and whole numbers.

1. Discuss how energy is used by each of us everyday. What are some of the environmental/ecological effects of energy use?
2. Distribute Exercise 9.1.
3. After students have completed the exercise, discuss their answers.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

1. Investigate HPOWER (Honolulu Project of Waste Energy Recycling). Call City Hall and invite a speaker to class to talk about HPOWER.
2. Find out what environmental pollution-control measures are being used by Kaiser Cement since they switched over to coal fuel.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

Exercise 9.1

"The Cost of Clean Living"

1. It has been estimated that the yearly cost of a 5-year clean-up program would be as follows: $26-29 billion for water, $12-15 billion for air in metropolitan areas, and $15 billion for solid waste disposal.
   a) What would the minimum cost of the 5 year program be?
   b) What would the maximum cost of the 5 year program be?
   c) If the population of the U.S. averages 210,000,000 in those 5 years, what would the minimum per capita cost for the clean-up program be? Maximum per capita cost?

2. The estimated air pollution emissions in 1970 for the State of Hawaii was 807,320 tons per year. Of this total 65% was assessed to the motor vehicle. How many tons of air pollutants was emitted by motor vehicles in 1970? If there was approximately 400,000 registered motor vehicles in 1970, how many tons of air pollutants did each vehicle emit each year? How many pounds each day?

3. In 1969, accidental spills, such as collisions, oil blow-outs, etc., accounted for 10% of the total oil pollution in the ocean. If 200,000 tons were contributed by these accidents, what was the total number of tons of oil pollution in the ocean?

4. In 1972 Russell Wyer of the Environmental Protection Agency reported that the 9,700 oil spills reported in 1971 represented only 20% of all oil spills. How many oil spills went unreported in 1971?

5. In 1976, the municipal solid waste (commercial, residential, and institutional sources) amounted to about 143 million tons. If the population of the United States was 220 million in 1976, what was the per capita generation of municipal solid waste per year?

6. Direct costs of municipal solid waste collection and disposal was estimated to be $4 billion a year in 1976. What was the cost per ton of municipal waste? What was the cost per person per year in 1976? (Use the data from Problem 5.)

7. The EPA reported that in 1976 there were 18,500 disposal sites. The average acreage of the disposal sites was 27.03 acres. How many acres of land was needed for the municipal solid waste in 1976?

181

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

Exercise 9.1 (Cont'd.)

8. The land area for the various islands are given below. Is the land area necessary for the 1976 disposal sites as described in Problem 7 enough to cover the island you live on? (Show calculations to support your answer.)

Island	Area (Sq. Miles)
Hawaii	4,030
Maui	728
Oahu	604
Kauai	555
Molokai	260
Lanai	141
Niihau	72
Kahoolawe	45

9. According to the data in Problem 7, how many islands the size of Niihau are needed to take care of the municipal wastes created in 1976?

10. List the environmental cost/benefits described or inferred in Problems 1-9.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

Worksheet 9.1

"A Graphic Representation"

Directions:
1. Number the "x" axis of the graph paper from 0 to 15.
2. Number the "y" axis from 0 to 20.
3. Plot each set of coordinates and connect each one as you proceed to the previous one.
4. When the word "lift" appears, lift your pencil and plot the next set of coordinates but do not connect it to the previous one.
5. Continue to plot all points and when you have completed the graphing, a picture will appear.

x	y
3.7	18.0
3.6	17.7
3.7	17.3
3.7	17.0
3.7	16.5
3.5	16.0
3.5	15.4
3.4	15.0
3.3	14.4
3.2	14.0
3.1	13.4
3.1	13.0
3.0	12.5
3.2	12.0
3.3	11.5
3.3	11.0
3.4	10.6
3.5	10.0
3.6	9.6
3.7	9.0
3.7	8.6
3.8	8.0
3.9	7.0
4.2	6.8
5.0	6.6
6.0	6.5
7.0	6.3
8.0	6.0
8.5	6.0
9.0	5.8

x	y
10.0	5.6
10.7	5.5
11.3	5.6
12.0	6.0
12.7	6.3
12.3	7.0
12.0	7.6
12.1	8.0
12.2	8.7
12.3	9.4
12.4	10.0
12.5	10.4
12.5	11.0
12.5	11.5
12.6	12.0
12.7	13.0
12.8	14.0
13.0	15.0
13.2	15.7
14.0	16.0
14.4	16.3
14.6	16.7
14.5	17.2
14.3	17.5
14.0	17.7
13.4	18.0
13.0	18.2
12.5	18.4
12.0	18.6
11.0	18.9

x	y
10.0	19.1
9.0	19.3
8.0	19.4
7.0	19.4
6.3	19.3
5.8	19.3
5.3	19.2
4.9	19.0
4.2	18.6
4.0	18.3
3.7	18.0
4.0	17.7
4.5	17.3
5.0	17.0
6.0	16.7
7.0	16.5
8.0	16.3
9.0	16.0
10.0	16.0
11.0	16.0
12.0	16.0
12.5	16.0
13.0	16.1
13.5	16.3
14.0	16.7
14.3	17.0
14.5	17.2
LIFT	
3.7	17.0

x	y
4.0	16.8
4.5	16.6
5.0	16.4
5.5	16.2
6.0	16.0
6.6	15.8
7.0	15.7
8.0	15.6
9.0	15.5
10.0	15.4
11.0	15.4
12.0	15.5
13.0	15.6
14.0	16.0
14.5	16.3
14.6	16.7
14.0	16.2
13.5	16.0
13.0	15.8
12.0	15.7
11.0	15.6
10.0	15.6
9.0	15.7
8.0	15.8
7.0	15.9
6.0	16.2
5.6	16.3
5.0	16.6
4.6	16.8
4.0	17.0

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

Worksheet 9.1 (Cont'd.)

x	y
3.7	17.3
LIFT	
7.5	18.0
6.6	17.6
LIFT	
7.3	17.9
7.7	17.8
8.5	17.9
9.0	17.8
10.0	17.4
10.7	17.0
11.1	16.8
LIFT	
6.8	17.7
7.3	17.5
8.0	17.6
8.4	17.7
9.0	17.3
10.0	17.0
10.6	16.6
LIFT	
11.4	17.0
10.4	16.6
LIFT	
3.8	7.7
3.4	7.5

x	y
3.3	7.2
3.3	7.0
3.4	6.6
4.0	6.2
4.5	5.9
5.0	5.8
5.5	5.7
6.0	5.8
6.4	5.6
7.0	5.6
8.0	5.4
9.0	5.3
10.0	5.1
10.4	5.0
11.0	5.2
11.3	5.3
12.0	5.6
12.3	5.8
12.7	6.3
LIFT	
11.3	12.7
10.4	12.7
10.3	11.6
10.0	11.4
10.2	11.0
10.0	10.8
10.2	10.4
10.5	10.3
11.0	10.2

x	y
11.5	10.3
12.0	10.5
12.2	10.8
12.2	11.0
12.0	11.3
11.8	11.5
11.3	11.7
11.3	12.7
LIFT	
11.4	11.4
10.5	11.3
10.3	11.2
10.5	11.0
10.4	10.7
10.5	10.5
11.0	10.4
11.3	10.5
11.7	10.7
12.0	11.0
11.5	11.4
LIFT	
6.0	3.0
6.0	4.0
6.5	4.0
6.5	3.5
6.0	3.5
6.5	3.0
LIFT	
7.5	4.0
7.0	4.0
7.0	3.0
7.5	3.0
LIFT	
7.0	3.5
7.5	3.5
LIFT	
8.5	4.0
8.0	4.0
8.0	3.0
8.5	3.0
LIFT	

x	y
9.0	4.0
9.4	3.5
9.4	3.0
LIFT	
9.8	4.0
9.4	3.5
LIFT	
10.5	4.0
10.0	4.0
10.0	3.0
10.5	3.0
LIFT	
11.0	4.0
11.0	3.0
11.5	3.0
LIFT	
12.5	4.0
12.0	4.0
12.0	3.0
12.5	3.0
LIFT	
12.5	3.5
12.0	3.5

Theme 9. Environmental/Ecological Considerations

Worksheet 9.1

Sample Activity 9-1

Grade Level 9-12

"A Graphic Representation"

185

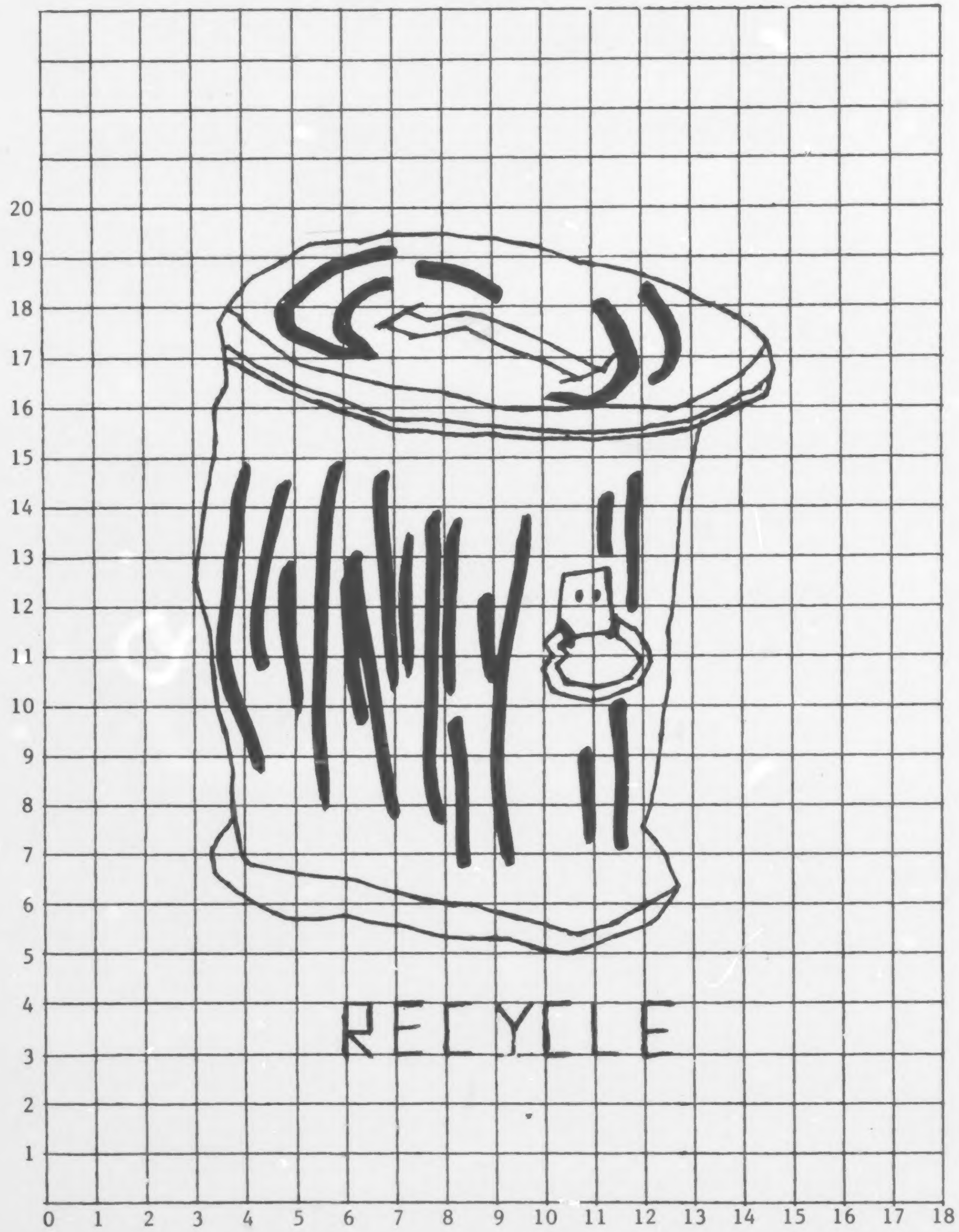
Theme 9. Environmental/Ecological Considerations

Sample Activity 9-1

Grade Level 9-12

Worksheet 9.1 - Teacher's Answer Sheet

"A Graphic Representation"



THEME 9. Environmental/Ecological Considerations

Subject Area Math (Bus, HEc, Sc, SS)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 9-2. "Paper Profits"

OBJECTIVE

- To know various energy options and their environmental/ecological benefits and consequences.

CONCEPTS

- Energy extraction and use alter and/or pollute natural environmental conditions.
- Trade-offs are necessary to resolve conflicts over energy use and the environment.
  a. A balance between short-term economic gains and long-term environmental quality involves trade-offs.
  b. The resolution of conflicts over conservation, land use, ecologically sound practices and aesthetic judgments involves trade-offs.
- Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of energy resources and their effects on the environment.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 3. Demonstrate writing skills commonly used in daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 7. Interpret common visual symbols.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will voluntarily participate in programs involving resource reclamation. (Goal: pg. D18)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-2

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option Y, Core Algebra)

- Performs the four basic operations with simple rational expressions. (pg. 126)
- For a real-world situation, prepares and uses a table to discover a relationship or to decide the best course of action. (pg. 127)
- Writes an algebraic expression to represent a verbal expression. (pg. 127)
- Given a verbal problem writes an appropriate equation, solves the equation, interprets the problem in terms of the problem setting. (pg. 127)
- Interprets a graph by stating what it shows and makes a table from it. (pg. 127)

SUGGESTED MATERIALS AND/OR RESOURCES

1. Exercise 9.2.
2. Worksheet 9.2.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-2

Grade Level 9-12

ACTIVITY (Related Core Themes: 1, 4, 5, 10 & 15)

The use of paper and paper products in our modern society has increased so dramatically that paper is now in short supply. The demand for more paper is reason enough to recycle paper. However, there are other reasons too. Recycling paper can conserve energy. If, as the EPA (Environmental Protection Agency) report indicates, it is "technically possible to recover half of the 70% of the mixed waste paper, the recycling of this portion (13.7 million tons) plus the 11.7 million tons of easily separable items could mean a fossil fuel energy savings equivalent to 2.4 billion gallons of gasoline per year."[1]

The savings of energy is not the only benefit to be gained from recycling. Recycling or reuse of materials eliminates the need to find places to dump or bury them. Also the use of recyclable materials in place of virgin materials in the manufacturing systems reduces the air and water effluents.

Although technological processes for materials recovery and/or fuel conversions are emerging, it is still important for informed and responsible citizens to take the necessary actions. For example, the purchase of returnable instead of throw-away beverage containers may mean changes in purchasing habits. Collecting and preparing newspapers, clear paper, cardboard, etc., for pick-up or delivery to a recycling center may mean giving up some leisure time. Whatever measures taken will make an impact on the energy use and the environment.

In this activity, students will use necessary algebraic skills to solve problems in resource recovery.

1. Discuss and/or review the definition of recycling with the students. Discuss some of the environmental cost/benefits of resource recovery.
2. Distribute Exercise 9.2.
3. Discuss Exercise 9.2.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Do Worksheet 9.2.

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[1] Energy in Solid Waste, Citizens' Advisory Committee On Environmental Quality, Washington, D.C., 1975, pg. 4.

Theme 9. Environmental/Ecological Considerations

Exercise 9.2

Sample Activity 9-2

Grade Level 9-12

"Paper Profits"

Directions: Solve the following problems. Express all fractions in their simplest form and all decimals to the nearest tenth place.

1. It takes 17 trees to make a ton of newsprint. How many trees would it take to make 53 million tons of newsprint? One billion tons?

2. The data in Table 1 shows the millions of tons of paper goods that were part of the municipal solid waste for the year 1975. If the solid waste for 1975 was 136,125,000 tons, what percent of the total 1975 municipal waste does the paper component represent?

Table 1. Some Components of Municipal Solid Waste, in 1975[1]

Materials	Million Tons
Newspaper	8.9
Books and Magazines	3.1
Office paper	5.2
Tissue paper, including towels	2.2
Paper plates, cups	.5
Corrugated paper	12.5
Paperboard	5.5
Paper packaging	5.1
Other packaging	2.2
Other non-packaging paper	1.0

Original Source: Environmental Protection Agency, Office of Solid Waste Management Programs, Resource Recovery and Waste Reduction. Report to Congress, EPA Publication SW-600, Washington, D.C., 1977, pg. 17.

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[1] Partial data from the Office of Technology Assessment. Materials and Energy from Municipal Waste. Resource Recovery and Recycling From Municipal Solid Waste and Beverage Container Deposit Legislation, Congress of United States, Washington, D.C., July 1979, pg. 26.

3. Assuming that recycled paper was not used in 1975, approximately how many trees were needed in 1975 to supply our newspaper needs? If people had 0.1% of their newspaper produced in 1975 stored away and not part of our municipal waste, what was the actual number of trees used in 1975?

Exercise 9.2 (Cont'd.)

4. On the average, there is a potential energy savings of 5.2 million BTU's per ton of paper. If this is so, what would the total energy savings be if 25% of all the paper goods listed in Table 1 was recycled?

5. If 35% of the newspapers, 28% of the books and magazines, 87% of the office paper and 62% of the corrugated paper were recycled in 1975, what would have been the total energy savings?

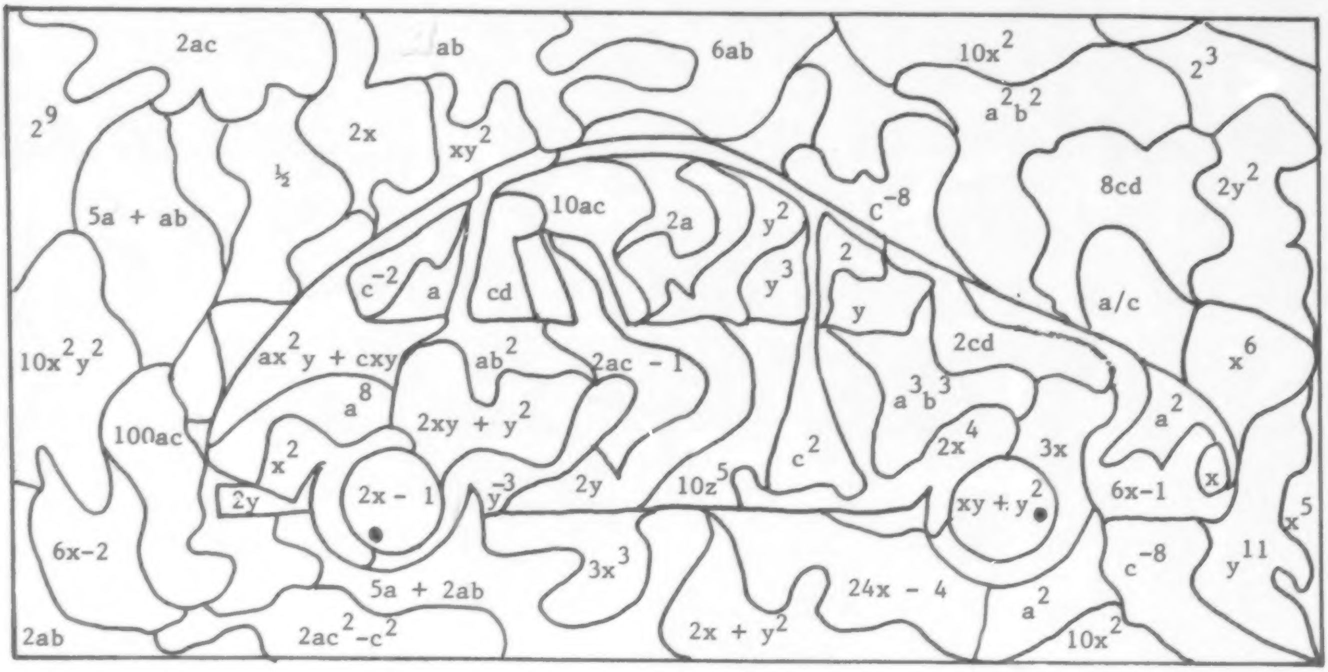
6. Given: (a) gasoline has an energy content of 5 1/4 million BTU/barrel and (b) the average American car has a fuel economy of 15 miles per gallon. If there are 2.7×10^{4} cars, what equal distances in miles can each car travel if net energy savings from Problem 5 were converted to equivalent amounts of gasoline? (Hint: a barrel of gasoline contains 42 gallons.)

Theme 9. Environmental/Ecological Considerations | Sample Activity 9-2

Worksheet 9.2 | Grade Level 9-12

"Let's Clear The Air"

Directions:
1. Solve the 20 problems below.
2. Next, look for the puzzle piece that contains an answer that matches yours.
3. Pencil in or color the entire puzzle piece.
4. After shading all 20 puzzle pieces, a picture concerning energy and our environment should appear.



Problems:

1. $a \times a =$
2. $b \times ab =$
3. $x^4 \div x^2 =$
4. $10a \times 10c =$
5. $a^2b \times ab^2 =$
6. $4cd \div 2 =$
7. $9x^2 \div 3x =$
8. $(2x + y)\, y =$
9. $x^2 \cdot 2x^2 =$
10. $2a + 3a + ab =$
11. $y + y =$
12. $y^4 \div y^7 =$
13. $(3x - 1)\, 2$
14. $a^3 \times a^5 =$
15. $c^{-3} \div c^{-5} =$
16. $2z \times 5z^4 =$
17. $5y \cdot 2x^2y =$
18. $(12x - 2) \div 2 =$
19. $(2ac^2 - c) \div c =$
20. $(ax + c) \cdot xy =$

Theme 9. Environmental/Ecological Considerations

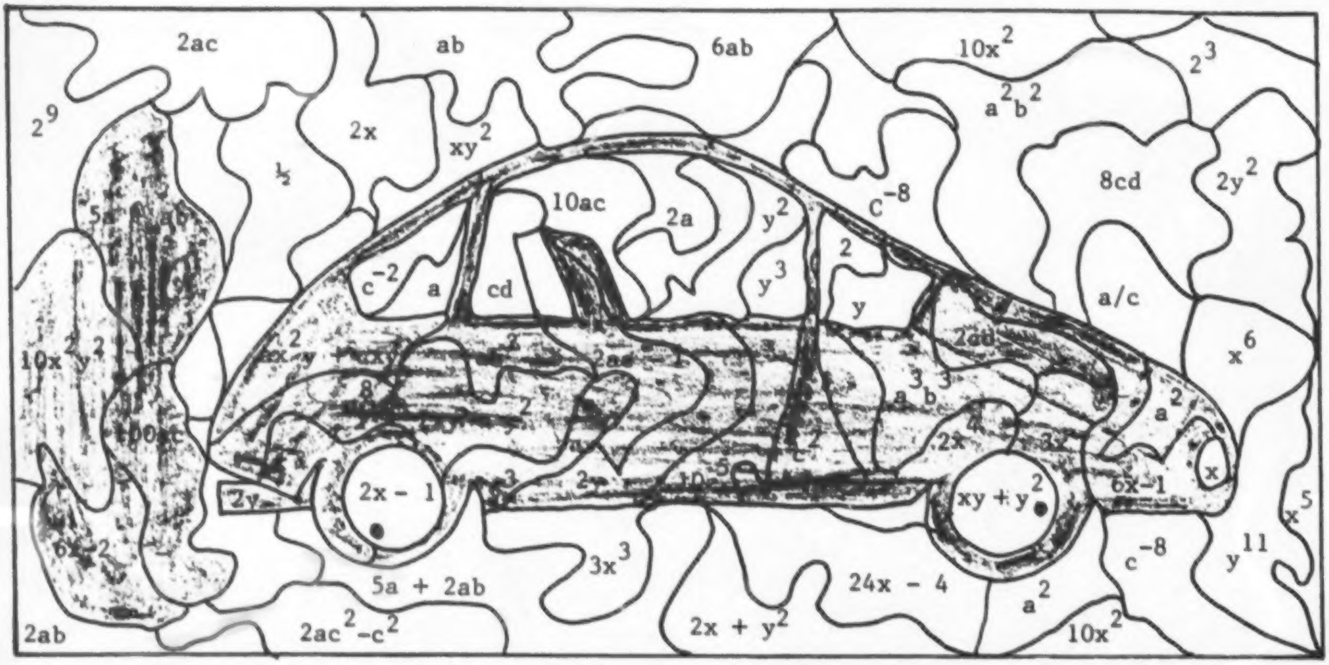
Sample Activity 9-2

Worksheet 9.2 - Teacher's Answer Sheet

Grade Level 9-12

"Let's Clear The Air"

Directions:
1. Solve the 20 problems below.
2. Next, look for the puzzle piece that contains an answer that matches yours.
3. Pencil in or color the entire puzzle piece.
4. After shading all 20 puzzle pieces, a picture concerning energy and our environment should appear.



Problems and Answers:

1. $a \times a = \underline{a^2}$
2. $b \times ab = \underline{ab^2}$
3. $x^4 \div x^2 = \underline{x^2}$
4. $10a \times 10c = \underline{100ac}$
5. $a^2b \times ab^2 = \underline{a^3b^3}$
6. $4cd \div 2 = \underline{2cd}$
7. $9x^2 \div 3x = \underline{3x}$
8. $(2x+y)y = \underline{2xy+y^2}$
9. $x^2 \cdot 2x^2 = \underline{2x^4}$
10. $2a+3a+ab = \underline{5a+ab}$
11. $y + y = \underline{2y}$
12. $y^4 \div y^7 = \underline{y^{-3}}$
13. $(3x-1)2 = \underline{6x-2}$
14. $a^3 \times a^5 = \underline{a^8}$
15. $c^{-3} \div c^{-5} = \underline{c^2}$
16. $2z \times 5z^4 = \underline{10z^5}$
17. $5y \cdot 2x^2y = \underline{10x^2y^2}$
18. $(12x-2) \div 2 = \underline{6x-1}$
19. $(2ac^2 - c) \div c = \underline{2ac-1}$
20. $(ax+c) \cdot xy = \underline{ax^2y + cxy}$

THEME 9. Environmental/Ecological Considerations

Subject Area Math (H, SS, Sc)
Thematic Area EE, G, LS, VE
Grade Level 9-12

SAMPLE ACTIVITY 9-3. "A Likely Occurrence"

OBJECTIVE

- To know various energy options and their environmental/ecological benefits and consequences.

CONCEPTS

- Energy extraction and use alters and/or pollutes original environmental conditions.
- Trade-offs are necessary to resolve conflicts over energy use and the environment.
  a. A balance between short-term economic gains and long-term environmental quality involves trade-offs.
  b. The resolution of conflicts over conservation, land use, ecologically sound practices and aesthetic judgments involves trade-offs.
- Political and cultural interest groups influence the decisions made regarding the development, use, and conservation of energy resources and their effects on the environment.

ESSENTIAL COMPETENCIES

- EC 1. Read and use printed materials from daily life.
- EC 4. Communicate orally in situations common to everyday life.
- EC 5. Use computational skills in situations common to everyday life.
- EC 8. Reach reasoned solutions to commonly encountered problems.
- EC 10. Use resources for independent learning.
- EC 11. Identify the harmful effects of smoking, drinking, drug abuse, overeating, insufficient sleep, poor personal hygiene, and poor nutrition.
- EC 13. Demonstrate knowledge of the basic structure and functions of national, state and local governments.
- EC 15. Demonstrate knowledge of important citizen rights and responsibilities.

RELATED ENVIRONMENTAL EDUCATION INSTRUCTIONAL GOALS AND/OR OBJECTIVES

- Students will support and practice wise utilization of traditional sources of energy and also support research and development of alternate energy sources. (Goal: pg. D2)
- When faced with decisions concerning the use of earth resources, students will select practices developed in recognition of present and future environmental and human needs. (Goal: pg. D6)
- Students will examine optional courses of action and their consequences for improving the quality of life and will support those that will provide optimum short- and long-term benefits for society and the environment. (Goal: pg. D38)

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-3

Grade Level 9-12

MATHEMATICS PROGRAM LEARNER OBJECTIVES (Option X, Level A/B; Option Y, Probability)

- Collects and classifies selected data, draws valid conclusions to make decisions. (pg. 123)
- Makes decision after interpreting data. (pg. 125)

SUGGESTED MATERIALS AND/OR RESOURCES

Exercise 9.3.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-3

Grade Level 9-12

ACTIVITY (Related Core Themes: 3 & 10)

One of the serious problems associated with energy use is the pollution of the environment and a disruption of the ecological balance. Unfortunately every time energy is used, the environment is affected. For example, when cavepersons built cooking fires, their fires caused some pollution. Today when we drive our cars, our cars cause some air pollution. The difference, however, is that today there are a lot more people.

The serious health, property, and environmental problems that have become such major and cr[illegible]l issues today, began to surface when we started to use fossil fuels [illegible]sively. Today the task of cleaning up and protecting our environment with new control programs costs the consumer money in the form of higher prices for energy and energy-related goods and services. Some people feel that we should put up with some environmental risks if we want to continue to reap the benefits of energy. Others feel that our environment should be protected at all cost. Perhaps the solution lies in finding the perfect balance between the cost of protecting our environment against the increasing costs incurred in controlling pollution. The question still facing us is "What is the best balance?"

In this activity students will learn more about pollution problems caused by energy use.

1. Discuss with the students how they use energy each day. Also discuss the effects of energy use on the environment. How is your use of energy each day affecting the environment? Are the effects all negative? Explain.
2. Next, have the students do Exercise 9.3. (Note: The information used in the exercise is factual unless stated otherwise.)
3. Discuss Exercise 9.3 with the students.

SUGGESTED FOLLOW-UP/ASSESSMENT ACTIVITIES

Find out what the air quality standards are for Hawaii. How often (if any) has the air pollution level been above the acceptable level? Which area(s) of the State is considered a high emission density zone? Are there similar standards for water, noise, and land pollution in our state?

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-3

Grade Level 9-12

Exercise 9.3

"A Likely Occurrence"*

Directions: Solve the following environmental/ecological problems.

1. At the Nimitz Used Car Lot, there are twelve 1975 cars, eight 1973 cars, ten 1970 cars, fifteen 1969 cars, and fifteen pre-1969 cars. All cars manufactured after 1970 have air pollution control devices.

    a. What is the probability that Lana (a customer) will buy a vehicle with a pollution control device?

    b. What is the probability that the first 3 cars sold will be non-polluting cars?

2. In 1948, Donora, Pennysylvania, a small town in the valley of the Monogahela River, had a population of approximately 12,000. During the month of October of that same year, a temperature inversion trapped the smoke from factories and fog, forming smog. The smog lasted for six days. Approximately 6,000 people became ill and 15 men and 5 women died. A temperature inversion of this sort occurs approximately 12 days each year in this community.

    a. What is the probability that a person will die from smog pollution on a given day?

    b. What is the probability that a person will become ill from smog pollution on a given day?

3. The lung cancer rate for men over 45 in the smoggiest part of Staten Island, New York, is 55 per 100,000. In the less smoggy areas, the rate is 40 per 100,000. Approximately one out of every three men over 45 live in the smoggiest area. What is the probability that a male over 45 living on Staten Island will have lung cancer?

4. The hazard due to smog is great for about ten percent of the population who are susceptible to lung ailments. In 1970, the NO_2 (nitrogen dioxide) level exceeded the safety level on 115 days in the Los Angeles Basin. What is the probability that the average citizen living in the Basin could become ill due to smog?

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*Some of problems used for this exercise were adapted from Environmental Education Guide, Mathematics 9-12. Project I-C-E (Instruction - Curriculum-Environment), Green Bay, Wisconsin, 1977.

Theme 9. Environmental/Ecological Considerations

Sample Activity 9-3

Grade Level 9-12

Exercise 9.3 (Cont'd.)

The next two problems are hypothetical in nature.

5. People recycle newspaper for many reasons. Some recycle paper for the money, while others for the energy it can conserve. A survey of the people who recycled paper in 1976 shows that 60,000 people recycled newspaper for the money. Of the 60,000 who recycled newspaper for money, 40,000 were teenagers 18 years or younger. The rest of the people who recycled newspaper in 1976, did it to conserve energy. Of this number, 20,000 were teenagers 18 years or younger.

   A recyling plant in Hawaii paid out $60,000,000 in 1976 at a rate of $.01 per pound of newspaper. It was estimated that on the average, a recycler in Hawaii brought in 600 pounds of newspaper per year. In 1976, the population of the State was 900,000.

   a. What is the probability that on any given day a teenager is at the recyling plant to recycle newspaper?

   b. What is the probability that on any given day the recycler is there because he/she wants to help conserve energy?

6. One way to conserve energy is to use renewable energy resources such as solar energy. The proper use of solar energy also helps to protect and preserve our environment. Assume that in 1979, there were approximately 180,000 homes in Hawaii. Further assume that 10,000 solar water heaters and 2,000 heat pumps were installed up to the end of that year.

   a. What is the probability that a house in Hawaii had a solar water heater in 1979? A heat pump?

   b. What is the probability that a house in Hawaii would have either a heat pump or a solar water heater in 1979?

   c. If the number of homes has increased by 1% and the number of solar water heaters by 2% and the number of heat pumps by ½%, what is the probability that a home has either a solar water heater or a heat pump today?

THEME 10. ENERGY COST, RESPONSIBILITY AND PRIVILEGE

BACKGROUND

Theme 10 focuses on the role and responsibility of (1) energy suppliers, especially the oil industry, (2) public interest groups such as the environmentalists,(3) energy consumers which include individual citizens, commerce and industry, and (4) government in protecting the privilege of energy consumption and in determining policies on the availability and cost of energy. This theme also deals with the problems involved in meeting the demands for an adequate, reliable energy supply at the lowest possible cost that is consistent with necessary environmental quality safeguards.

Individuals can contribute to the solution of these problems by reducing energy waste through more responsible and efficient use of energy. It is the privilege as well as the responsibility of citizens in a free enterprise system to develop competence in making rational and appropriate decisions about their consumption of energy-related goods and services. For example, energy consumers must consider the diminishing supply of fossil fuels and the rising cost of energy when making decisions on replacements or purchases of cars, appliances, homes, etc.

The private enterprise system can also make contributions to the solutions of energy-related problems. Employers can make energy conservation a high priority while businesses can develop better processes and practices to use energy more efficiently. In addition, oil industries can improve techniques for extracting and using energy as well as search for and develop other energy alternatives.

Research and development of energy alternatives should provide further relief to the problems of short supply and escalating costs of energy. This issue involves decision-making by citizens about the role of government in the research, development, financing, regulation, and ownership of alternate energy resources. It also involves the privilege and responsibility of oil industries and other energy suppliers to finance the research and development of present and future energy resources.

Understanding of this theme should enable students to realize the importance of an open and candid government and private enterprise system that has the responsibility to inform and enlighten the public about their energy-related policies and decisions. Wide public consumer support of and cooperation among government, commerce and industry are essential for continued economic prosperity and growth and the maintenance or improvement of our quality of life.

Theme 10. Energy Cost, Responsibility and Privilege

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To understand the various energy cost/responsibility/privilege interrelationships.

CONCEPTS

1. Government at all levels has a critical role to play in guiding the course of energy production and use.
2. The key factors affecting the availability of energy supplies are national economic policies, environmental legislation, and funding for research and development of untapped and new sources of energy.
3. Business and industry have the privilege and responsibility for increasing energy production while developing new sources of energy to meet demands at the lowest possible costs.
4. Individual citizens have the privilege and responsibility to keep informed, make value judgments and take actions which protect their environment, encourage conservation, reduce demands for energy, and curtail energy costs.

THEME 10. Energy Cost, Responsibility and Privilege

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 62 - Unit X) Capital is needed to start, maintain, and expand agricultural enterprises.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HOME ECONOMICS: (pg. iii - Objective) Take an intelligent part in legislative and other social action programs which directly affect the welfare of individuals and families.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an understanding of the nature and significance of materials, tools, processes, products, and occupations of our technological world, and their impact upon our society.

LANGUAGE ARTS: (pg. 4 - Goal) To increase student understandings of the nature and structure of the English language within the broad perspective of communication.

MATHEMATICS: (pg. 13 - Goal) Develop ability to think critically and to solve problems.

PHYSICAL EDUCATION: (pg. 106 - Objective) Learn to respect the rights of others, help the less-skilled players, subordinate their own desires to the will of the group and realize they have the responsibility of directing their actions in behalf of the group.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Help students to analyze and synthesize holistically (using knowledge from various disciplines) in solving a problem. 2. Prepare the children for useful, effective citizenship in an increasingly complex and technological society by developing an interest in and a curiosity about the future both for themselves and for the civilization of which they are a part. 3. Teach science as a unified discipline intergrated and/or coordinated with other disciplines such as math, social studies, language arts, art, etc.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to construct, evaluate, and revise alternatives for personal goals, plans, or problem solutions, considering costs and benefits to self and to others affected by his or her decisions.

THEME 10. Energy Cost, Responsibility and Privilege

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. Study the rate structures of utility companies, such as their practice of encouraging a lower rate for larger users, increased rates for expansion and profit margins. Should the utility companies compensate consumers who use less energy? Explain. What rate structure would you suggest that would be fair and equitable to all consumers?

2. The law of supply and demand forces prices up when resources become scarce. When cost goes too high, there is a shift to use replacements and substitutes. List some of your favorite possessions that are made from oil or gas (synthetic fibers, plastics, etc.) and predict what might happen to the cost and availability of these as oil and gas become scarce. Conduct a survey to find out what oil-based products people are willing to do without as petroleum becomes scarce.

3. Find out the per capita energy consumption for various nations of the world. Is the consumption of energy fair? What is the average per capita energy consumption for a resident in the United States? Are Americans using more than their fair share of energy?

4. Calculate the total KWH consumed by you and your family each month. If you were asked to reduce your energy consumption by 15%, what energy user would you be willing to give up?

5. Conduct an energy audit of your home. Calculate the possible dollar and energy savings that could take place if you were to change your "energy habits."

VOCABULARY

Allocation of resources, attitude, behavior, cause and effect, energy cost, demand and supply, influence, privilege, responsibility, value, wants.

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[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.
b. Energy in Solid Waste. Citizens' Advisory Committee on Environmental Quality, Washington, D.C., 1975.
c. Tips for Energy Savers. U.S. Department of Energy. Washington, D. C., September 1978.

THEME 11. ENERGY VS. POPULATION VS. FOOD

BACKGROUND

Theme 11 deals with population density as a factor which influences the exploitation of an area's natural resources and thus the availability of the energy resources in that area. It also considers the effects of population changes on supplies of and the demands for energy and food. For example, an increase in population results in greater demands for food production. Then, as food production is increased more energy is used. The earth's resources are limited, however, and can support only a limited population.

It should be noted that food production can be viewed as both a source and a user of energy. As an energy source, food provides human beings with fuel for their bodies. As an energy user, food production requires energy.

Understanding of the various energy/population/food interrelationships should enable students to appreciate energy as the key link to life. It should also help them to realize that the earth's resources are finite and, even with optimum recycling systems, can support only a limited population. This understanding should also encourage students to adopt values and practices based on the wise and judicious use of energy and food.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 5. Develop physical, social and emotional health.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.

CORE THEME OBJECTIVE

To understand the various energy/population/food interrelationships.

CONCEPTS

1. Population changes directly influence energy demands, availability and supply.
2. Population density of an area may influence the demand for and possible use patterns of energy resources.
3. Population changes directly influence food consumption and supply.
4. Food production requires tremendous amounts of energy and money.
5. The use of Hawaii's limited prime agricultural land resources is being directed towards trying to achieve self-sufficiency in food production.
6. Hawaii's policy on population is to manage population growth rates throughout the state consistent with available and planned energy resources.

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 59 - Unit VII) Agriculture is faced with environmental problems that are both internal and external.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 6 - Goal) To become acquainted with the significant characteristics of the countries or areas where the language is spoken.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively meet the basic necessities of life in order to sustain life to the optimum. To develop an awareness of the needs of society for goods and services and how goods and services are effectively provided.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HEALTH: (pg. iii & 1 - Goal) Through a developmental health education program, students will acquire accurate health information, and gain experiences contributing to attitudes, values and responsible health practices; students will be able to make decisions relating to their health and understand how these decisions affect them and the society in which they live.

HOME ECONOMICS: (pg. iii - Objective) Develop mutual understanding and appreciation of differing cultures and ways of life, and co-operate with people of other cultures who are striving to raise levels of living.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop ability to think critically and to solve problems.

SCIENCE: (pg. A-13 - Objective) Expose students to cross-cultural comparisons of critical bio-social issues, i.e., race relations, family structure, male-female roles, human resources and others.

SOCIAL STUDIES: (pg. 12 - Objective) The student values knowledge and skills enabling individuals, groups, and societies to cope effectively with the complexity of human circumstances.

Theme 11. Energy vs Population vs Food

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. Investigate the energy consumption of various countries and/or nations. Graph the per capita consumption of energy of each of the countries investigated.

2. Obtain a projection of the population in Hawaii for the year 2000 or make a projection based on previous population trends. Based on the projection, calculate the amount of energy that will be used in the year 2000 in Hawaii.

3. On a large table mark off an area 1 meter square (or work outside in the school yard). Get a box of counting blocks (other materials may be substituted such as empty soda cans, marbles, etc.). Let one block represent one person. Start off your population with 2 blocks (people). Every thirty seconds, add 8 blocks (people) to your 1 meter square (our world). This represents the number of people being born every 2 seconds in real life. Take away 3 blocks (people) every 30 seconds. This represents those people who die in real life every 2 seconds. What happens to your world after a few minutes? After 10 minutes? How is energy consumption affected? How is food supply affected? The same thing is happening in the real world. That is, every second, 4 babies are born and 1.6 people die. Every second we add 2.4 people to the world. How many people are added to the world in a minute? In a day? In a year? How will this population growth affect our fossil fuel supply?

VOCABULARY

Allocation of resources, BTU's, calories, conservation, energy consumption, fossil fuel, fuel, non-renewable, per capita, population, population density, renewable, resource reclamation, supply and demand, values, wants.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Energy: Use, Conservation and Supply. American Association for the Advancement of Science. Washington, D.C., 1974.
b. Ecoscience: Population, Resources, Environment by Paul and Anne Ehrlich and John Holdren. W.H. Freeman and Co., San Francisco, California, 1977.
c. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.

THEME 12. ENERGY INTERDEPENDENCE

BACKGROUND

In this theme, students will consider energy-related issues which are international in scope. For example, they will analyze different patterns of natural resources which exist around the world in terms of the geographic distribution of trade for energy resources. They will also evaluate how the demand for energy resources has promoted international trade and linked areas of the world together in an economically interdependent manner.

Due to factors of comparative advantage and gains received from trade, nations have increased their engagements in exchanging energy resources. In 1968, 33% of primary energy consumed in the world crossed foreign borders. Countries with a comparative disadvantage in the production of energy resources, however, import more energy resources than they produce. For example, about half of the oil consumed in the United States and nearly all of Hawaii's energy resources are imported at the present time. It is important that students understand the significance of sharing among nations and world interdependency. They should also be aware of the geographic, environmental, social and political factors which influence energy-related international trade.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.

CORE THEME OBJECTIVE

To understand current energy exchange practices which link nations in an economically, socially and politically interdependent manner.

Theme 12. Energy Interdependence

CONCEPTS

1. Energy resources are unevenly distributed around the world.
2. Regional availability of particular energy resources and the growing demands for these resources foster international trade and link the world together in an economically interdependent manner.
3. The complex network of international factors influence the import/export patterns of nations and the availability and use of energy resources. These factors include: cartel, international supply and demand factors, balance of payments, patterns of trade, terms of trade, comparative advantage, political and ideological factors, exchange rates, money flows and price changes, etc.
4. Hawaii is very dependent on imported oil from foreign countries.

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 58 - Unit VI) Efficient processing, marketing, and distribution are essential in making agricultural products economically available to man.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 8 - Goal) An understanding of the interdependency of nations.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To develop an awareness of the needs of society for goods and services and how goods and services are effectively provided.

BUSINESS EDUCATION: (pg. V - Objectives) 1. To live effectively in today's economic environment. 2. To meet the ever-changing demands of the business world of work.

HOME ECONOMICS: (pg. iii - Objective) Develop mutual understanding and appreciation of differing cultures and ways of life, and co-operate with people of other cultures who are striving to raise levels of living.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Develop an understanding of the nature and significance of materials, tools, processes, products, and occupations of our technological world, and their impact upon our society.

LANGUAGE ARTS: (pg. 4 - Goal) To increase student understandings of the nature and structure of the English language within the broad perspective of communication.

MATHEMATICS: (pg. 3 - Goal) Develop mathematical competence to function effectively in today's society.

MUSIC: (pg. - Objective) Demonstrate an understanding and appreciation of the music of their own culture, as well as the music of other cultures.

SCIENCE: (pg. A-13 - Objective) Expose students to cross-cultural comparisons of critical bio-social issues, i.e., race relations, family structure, male-female roles, human resources and others.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to identify and analyze problems and issues by which he or she is affected as a member of a changing multicultural society.

Theme 12. Energy Interdependence

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. Research and calculate the percentage of the world's oil, coal, and natural gas owned by the United States. What percent of the world's output do we actually use? How much fossil fuel energy do we import? How much does the State of Hawaii import? Research and find out from which countries the United States imports oil. What percent of our imported oil comes from each of these countries?

2. Use a map of the world and other references and locate land areas that contain fossil fuels (coal, oil or natural gas). Find out how much of the world's fossil fuel is estimated to be in each location. What percent of the world's current consumption is actually being produced in each location? Is there a relationship between availability of fossil fuel reserves and energy production? Why or why not?

3. Investigate the food products imported in and exported out of Hawaii. What is the net balance of trade for the food industry in Hawaii? If the food products are translated into energy costs, what is the net balance of energy for food products in Hawaii?

VOCABULARY

Allocation of resources, balance of payments, balance of trade, calorie, cartel, embargo, energy costs, export, fossil fuel, fossil fuel reserves, import, life style, net energy, OPEC, price control, standard of living, supply and demand, trade, trade deficits.

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[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Two Energy Gulfs. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy (EEE), U.S. Department of Energy, Technical Information Center, Oak Ridge, Tennessee, March 1979.
b. Ecoscience: Population, Resources, Environment by Paul and Anne Ehrlich and John Holdren. W.H. Freeman and Co., San Francisco, California, 1977.
c. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.

THEME 13. ENERGY SELF-SUFFICIENCY

BACKGROUND

Theme 13 explores the movement towards complete self-sufficiency as part of the continuing search for dependable, adequate, efficient and economical sources of energy. It also considers the impacts of technology and the political, social, aesthetic, and moral attitudes and values on this movement.

Very few areas of the world are able or willing to be completely independent of other areas for the production and consumption of energy resouces. However in recent years, the Organization of Petroleum Exporting Countries (OPEC) has provided momentum for the movement toward self-sufficiency by its cartel-like behavior which resulted in cycles of oil surpluses and shortages. For example, the United States is dependent upon OPEC nations for some of its energy needs. To reduce this dependency and to strive for self-sufficiency, research on new and/or alternate energy sources is being undertaken. Conservation practices are also being encouraged.

Regardless of OPEC's actions, it is important for individuals to realize that the energy sources that we are currently using are being depleted and are for the most part non-renewable. Thus, this theme should help students understand that new patterns of energy consumption will have to evolve and that they must be prepared to cope with changes to lifestyles if self-sufficiency is to become a reality.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To understand the movement toward complete self-sufficiency as necessary and feasible.

Theme 13. Energy Self-Sufficiency

CONCEPTS

1. Self-sufficiency in terms of energy means the ability to provide energy resources in amounts necessary to meet domestic demands.
2. The problems of availability and control of energy resources make it necessary for nations to become self-sufficient.
3. Level of technology and the political, social, aesthetic and moral attitudes and values influence a nation's movement toward complete self-sufficiency.
4. Movement toward self-sufficiency will necessitate changes in life styles.
5. The State of Hawaii's plan is to reach net energy self-sufficiency by the year 2025 through research and the development of new and indigenous energy sources.

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 61 - Unit IX) Continued research and experimentation are required for advancement in agricultural productivity and human's well being.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) An understanding of the geographic influences upon the economic and social development of the country.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To develop the ability to cope with change.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HOME ECONOMICS: (pg. iii - Objective) Make and carry out intelligent decisions regarding the use of personal, family, and community resources.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop ability to think critically and to solve problems.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Help students to analyze and synthesize holistically (using knowledge from various disciplines) in solving a problem. 2. Prepare the children for useful, effective citizenship in an increasingly complex and technological society by developing an interest in and a curiosity about the future both for themselves and for the civilization of which they are a part.

SOCIAL STUDIES: (pg. 11- Objective) The student is able to participate actively and responsibly in collective decisions affecting the social, economic, political, or physical environment in which he or she lives.

Theme 13. Energy Self-Sufficiency

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. It has been said that Hawaii has the technological capabilities to become independent of foreign oil. Make a chart of the projected energy demands for 1990. What is the renewable energy supply potential for each of the islands in the State?

2. The development of renewable energy systems is capital intensive. However many people feel that the costs will eventually be more than offset by the very low or nonexistent fuel cost factor compare with the escalating price of oil. The yearly cost of oil is projected at 10% increase compounded annually. Gather the necessary information and calculate (based on the 1980 dollar) how many years from today, an investment in a renewable energy system (such as a windmill) would pay for itself.

VOCABULARY

Allocation of resources, balance of payments, balance of trade, capital intensive, energy independence, export, import, labor intensive, lifestyle, net self-sufficiency, OPEC, price control, renewable energy sources, scarcity, supply and demand, technology, trade.

[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. U.S. Energy Policy-Which Direction? Interdisciplinary Student/Teacher Materials in Energy, the Environment and the Economy, U.S. Department of Energy, Technical Information Office, Oak Ridge, Tennessee, 1978.
b. Legislative Energy RD&D Workshop Handbook. Hawaii State Senate, Economic Development and Energy Committee, State of Hawaii, Honolulu, Hawaii, November 1979.
c. Ecoscience: Population, Resources, Environment by Paul and Anne Ehrlich and John Holdren. W. H. Freeman and Co., San Francisco, California, 1977.
d. Energy-Environment Source Book by John Fowler. National Science Teachers Association, Energy-Environment Materials Project, Washington, D.C., 1975.

THEME 14. APPROPRIATE ENERGY TECHNOLOGY

BACKGROUND

Theme 14 focuses on appropriate energy technology as a fundamentally different approach to meeting the social and economic needs of human beings. Appropriate technology includes tools, techniques, processes, and ways of thinking and acting which maintain or improve our quality of life. It is a trend away from energy-intensive or hard technology and a movement toward labor-intensive or soft technology to insure an energy future which is affordable, sustainable, and ecologically sound.

The cheap-energy or hard technology based on fossil fuels has contributed to many of our environmental, economic, and social problems. Long-term solutions to these problems are being sought as part of the planning being done for a future based on additional and different sources of energy. Thus, technology that is more appropriate than that which now is used by our society is needed for this transition from fossil fuels to alternate energy sources. Examples of appropriate technology include solar energy systems, wind energy systems, solid waste recycling systems, composting, organic gardening and farming, development of bicycle and low-speed mass transportation networks, use of climate-based design in home construction, "cottage" or home-based industries, etc. Such technology will necessitate major changes in personal lifestyles and social goals.

This theme should help students understand the need for alternative goals and directions that value human activity, preserve the natural environment, and involve appropriate energy technology. Attainment of these goals should maintain or improve the quality of life for all.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To understand that energy technology has to fit the use to which it is put with minimum negative effects upon the quality of life.

Theme 14. Appropriate Energy Technology

CONCEPTS

1. Appropriate energy technology is simple and efficient, makes best use of available renewable energy resources, conserves non-renewable resources, depends largely upon human labor, emphasizes the use of local materials and skills, is small-scale, decentralized, self-sustaining, and non-polluting.
2. The political, social, aesthetic and moral attitudes and values of a society influence and are influenced by the development and use of appropriate energy technology.
3. The development and use of appropriate energy technology will require major changes in personal lifestyles and social goals.
4. As one of the first selected pilot sites in the nation, Hawaii has undertaken a wide variety of projects involving appropriate energy technology.

Theme 14. Appropriate Energy Technology

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 61 - Unit IX) Continued research and experimentation are required for advancement in agricultural productivity and human's well being.

ART: (pg. 7 - Objective) Use the potentialities of art and take action to shape and enhance the quality of one's personal and public environment.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) An understanding of how governments are similar to and different from our own in solving their problems.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To effectively utilize the resources of our technological world and to understand the importance of conservation.

BUSINESS EDUCATION: (pg. V - Objective) To live effectively in today's economic environment.

HOME ECONOMICS: (pg. iii - Objective) Perform the tasks of maintaining a home in such a way that they will contribute effectively to furthering individual and family goals.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation and education.

LANGUAGE ARTS: (pg. 4 - Goal) To assist students to develop the highest degree of informed control of which they are capable over their use of language.

MATHEMATICS: (pg. 13 - Goal) Develop an understanding of the importance and relevance of mathematics historically and in the world today.

SCIENCE: (pg. A-14 - Objectives) 1. Encourage students to maintain a safe and healthy environment. 2. Help students gain experience with the potentialities and limitations of the methods of scientific and social investigation but at the same time recognize that the environment can be interpreted and manipulated.

SOCIAL STUDIES: (pg. 11 - Objectives) 1. The student is able to construct, evaluate, and revise alternatives for personal goals, plans, or problem solutions, considering costs and benefits to self and to others affected by his or her decisions. 2. The student is able to participate actively and responsibly in collective decisions affecting the social, economic, political, or physical environment in which he or she lives.

Theme 14. Appropriate Energy Technology Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. The underlying purpose of appropriate technology is to make the best use of available renewable energy resources appropriate to the region or locality. Compare the energy consumed by a solar water heater and a conventional electrical or gas water heater for a given household. Which method of heating water uses energy more efficiently? Which method is more cost efficient? Which method conserves energy? How much energy is conserved?

2. Compare the feasibility of various renewable energy sources for Hawaii. Which renewable energy source is the most cost efficient? Calculate the efficiency cost of each renewable energy source to show proof of your answer.

VOCABULARY

Appropriate technology, biomass conversion, cost efficiency, energy efficient, energy intensive, energy self-sufficiency, environmentally sound, "hard" technology, inappropriate technology, labor intensive, life style, methane generation, non-polluting, passive technology, recyle, renewable energy, "soft" technology, solar energy, technology, waste energy recovery, waste heat recovery.

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[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Legislative Energy RD&D Workshop Handbook. Hawaii State Senate, Economic Development and Energy Committee, State of Hawaii, Honolulu, Hawaii, November 1979.
b. Application of Solar Technology to Today's Energy Needs. Congress of the United States, Office of Technology Assessment, Washington, D.C., June 1978.
c. Appropriate Energy Technology in Hawaii. Department of Planning and Economic Development, State Energy Office, Honolulu, Hawaii, October 1979.
d. Energy Self-Sufficiency for the State of Hawaii by University of Hawaii Students of Civil Engineering/Interdisciplinary Studies, published through a grant from National Science Foundation, University of Hawaii at Manoa, Honolulu, Hawaii, September 1978.
e. Solar/Wind Handbook for Hawaii by Waqidi Falicoff, George Koide, and Pat Takahashi, U.S. Department of Energy in cooperation with University of Hawaii at Manoa, University of Hawaii at Hilo and the State of Hawaii (State Energy Office), Honolulu, Hawaii, May 1979.

THEME 15. FUTURE PERSPECTIVE

BACKGROUND

In theme 15, students consider the various ways in which they can participate in creating an energy secure future. An understanding of all facets of today's energy-related problems and issues and consideration of the range of consequences of today's decisions and actions will help students to envision these possible futures.

The students explore their values and make their own decisions when confronted with difficult but necessary choices in formulating plans and actions to achieve a preferred future. This kind of decision-making involves an objective and rational assessment of the future outcomes of alternative actions and policies regarding energy use and the environment. These decisions and actions are based on the values of society, and understanding of basic science and natural science concepts, technological development, economic factors and environmental and ecological considerations.

Development and examination of alternatives and all possible outcomes of many possible futures will help students realize the importance of being flexible and adaptable. This will enable them to better cope with rapidly changing technology and political, social and economic circumstances affecting energy use and the environment.

The students should understand that as individual citizens, they need to have an active say in and be in control of their futures planning. They should also understand that decisions made today will affect both their own lives and those of generations to come.

FOUNDATION PROGRAM OBJECTIVES

FPO 1. Develop basic skills for learning and effective communication with others.
FPO 2. Develop positive self-concept.
FPO 3. Develop decision-making and problem-solving skills at the student's proficiency level.
FPO 4. Develop independence in learning.
FPO 5. Develop physical, social and emotional health.
FPO 6. Recognize and pursue career development as an integral part of growth and development.
FPO 7. Develop a continually growing philosophy such that the student is responsible to self as well as to others.
FPO 8. Develop creative potential and aesthetic sensitivity.

CORE THEME OBJECTIVE

To utilize decision-making and problem-solving skills in formulating plans and actions to achieve a preferred future in energy use and the environment.

Theme 15. Future Perspective

CONCEPTS

1. Energy availability and changes in the attitudes of individuals and societies regarding energy use will affect our future lifestyles.
2. Economic, social, political, and technological decisions made now will affect the availability, distribution and use of energy in the future.
3. The State of Hawaii is in the process of developing a functional plan for a preferred future regarding energy use and the environment.

Theme 15. Future Perspective

RELATED GOALS AND/OR GENERAL OBJECTIVES OF SUBJECT AREA GUIDES

AGRICULTURE: (pg. 57 - Unit V) In order to reach desired goals, man must be able to employ effective management practices.

ART: (pg. 7 - Objective) Use potentialities of art and take action to shape and enhance the quality of one's personal and public environment.

ASIAN, EUROPEAN AND PACIFIC LANGUAGES: (pg. 7 - Goal) An understanding of how governments are similar to and different from our own in solving their problems.

BASIC PRACTICAL ARTS: (pg. 4 - Objective) To understand the elements of management and effective management practices as they relate to our technological society.

BUSINESS EDUCATION: (pg. V - Objectives) 1. To live effectively in today's economic environment. 2. To meet the ever-changing demands of the business world of work.

HOME ECONOMICS: (pg. iii - Objective) Establish long-range goals for financial security and work toward their environment.

INDUSTRIAL ARTS/INDUS-TECH: (pg. 2 - Objective) Apply technical knowledge and techniques for effective living in situations such as recreation, consumption, occupation, and education.

LANGUAGE ARTS: (pg. 4 - Goal) To increase student understanding of the nature and structure of the English language within the broad perspective of communication.

MATHEMATICS: (pg. 13 - Goal) Develop ability to think critically and to solve problems.

PHYSICAL EDUCATION: (pg. 106 - Objective) Acquire the habit of participating in wholesome recreational activities.

SCIENCE: (pg. A-13 & 14 - Objectives) 1. Help students to analyze and synthesize holistically (using knowledge from various disciplines) in solving a problem. 2. Prepare the children for useful, effective citizenship in an increasingly complex and technological society by developing an interest in and a curiosity about the future both for themselves and for the civilization of which they are a part. 3. Facilitate a positive self-concept through the development of self-pride and a sense of accomplishment by encouraging self-expression of conventional and unusual ideas as well as independence in learning.

SOCIAL STUDIES: (pg. 11 - Objective) The student is able to select and use appropriate criteria, procedures, and information sources to assess the validity or significance of findings about past, present, or future human life or affairs.

Theme 15. Future Perspective

Subject Area Mathematics

Grade Level 7-12

THINGS TO DO[1]

1. Obtain a projection of the population in Hawaii for the year 2000, or make your own projection based on population trends over the past years. Based on the projection, calculate the amount of paper that will be used in the year 2000 in Hawaii. How much energy will be consumed in the production of paper for the year 2000 in Hawaii? If all this paper becomes waste, how much landfill space would be require for it. (Assume 200 cubic feet per ton of paper.) If all of this paper is recycled, how much energy will be conserved?

2. Use statistical data from the State Energy Office and U.S. Department of Energy to predict and project future energy consumption trends.

3. Calculate the barrels of oil conserved if Hawaii passed a law making it mandatory that all registered vehicles have a fuel economy of 17 mpg or better.

VOCABULARY

Allocation of resources, appropriate energy technology, biomass conversion, conservation, conservation ethic, energy self-sufficiency, labor intensive, life style, needs, recycle, renewable energy source, resource reclamation, solar energy, supply and demand, technology, values, wants, waste energy recovery.

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[1] Note to teacher: The suggested activities can be adapted to any math class and math course. Other energy math problems can be formulated using various reference materials. Some reference materials to consider are:

a. Legislative Energy RD&D Workshop Handbook. Hawaii State Senate, Economic Development and Energy Committee, State of Hawaii, Honolulu, Hawaii, November 1979.
b. Appropriate Energy Technology in Hawaii. Department of Planning and Economic Development, State Energy Office, Honolulu, Hawaii, October 1979.
c. State of Hawaii Energy Policies Plan. General Plan Revision Program, Department of Planning and Economic Development, State of Hawaii, Honolulu, Hawaii. (Ask for latest energy policies plan.)
d. Publications from the State Energy Office and Federal Energy Office.
e. Annual Reports from Hawaii Natural Energy Institute (HNEI), University of Hawaii at Manoa, Honolulu, Hawaii.

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